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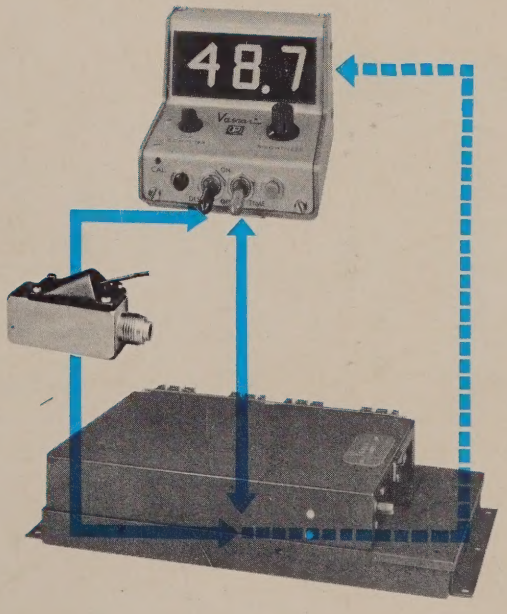
Service Manual

Vascar® II



FEDERAL SIGN AND SIGNAL CORPORATION

* VASCAR II
SERVICE MANUAL

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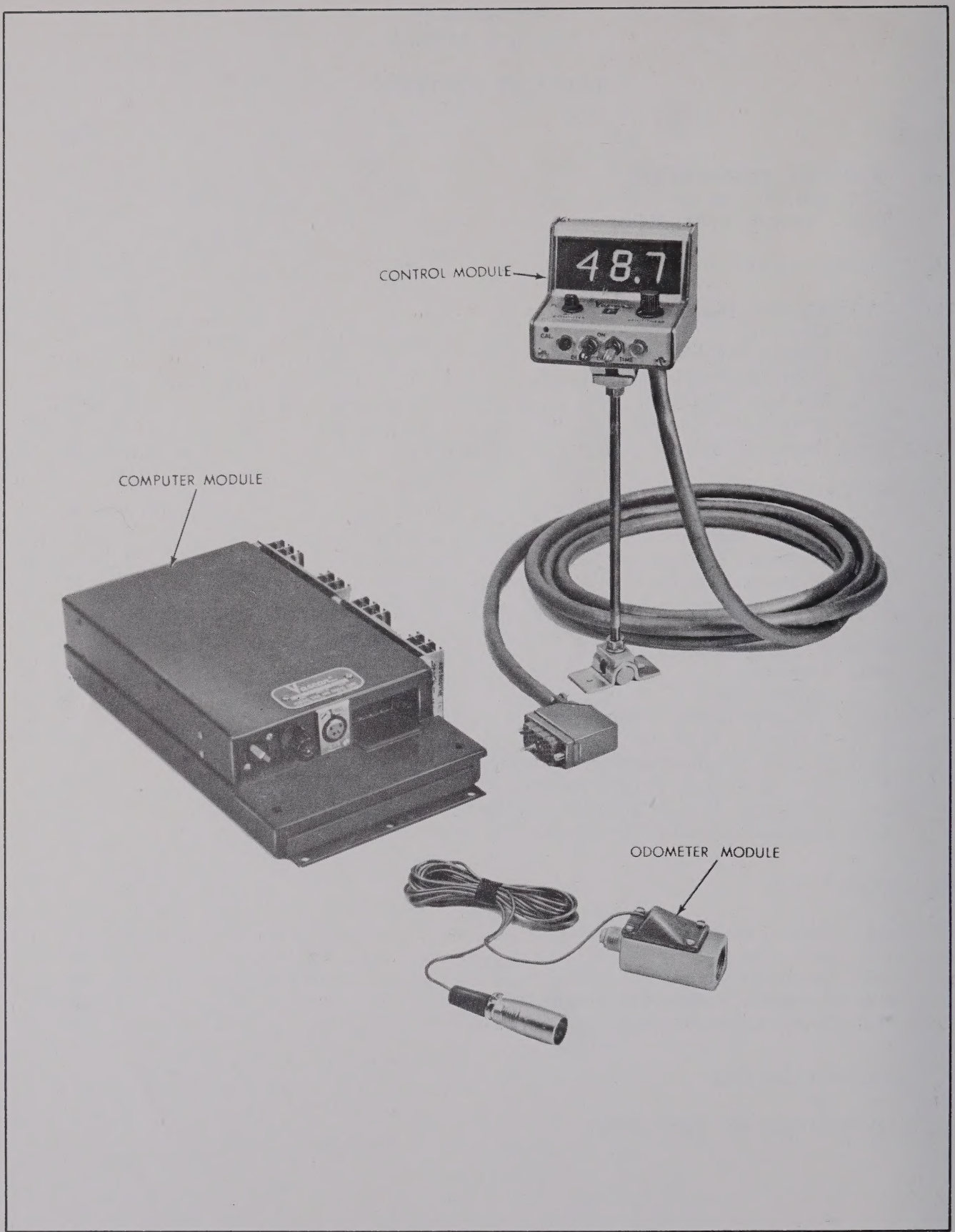


Figure 1. Federal's VASCAR II System.

SECTION I

GENERAL DESCRIPTION

1–1. INTRODUCTION.

VASCAR II is a precision built, compact, solid-state special purpose electronic digital computer of advanced design. When properly installed in a vehicle, it will compute speeds of other vehicles by dividing the distance as measured between two reference points by the time it takes another vehicle to travel between these same two reference points. A digital readout will display this average speed in tenths of a mile per hour up to 199.9 MPH.

The device consists of a Control Module, Odometer Module and Computer Module (see figure 1). The Control Module contains all the controls and indicators used by an operator during normal operation. Time and distance information inputs are controlled by two toggle switches. The toggle switch nearest the operator (black cap) is used to start and stop the distance information input. The toggle switch at the right (red cap) is used to start and stop the time information input. Distance is always measured by the vehicle in which the VASCAR II is installed, and time is always measured on the target vehicle.

At the completion of each "clock" it is necessary to clear the computer for the next "clock". This is accomplished by depressing the black DIST. pushbutton on the left side of the face of the Control Module. The red TIME button (located on the right side of the face of the Control Module) is depressed to clear the time recorded, but store the distance in the computer for repeated use.

1–2. GENERAL DESCRIPTION.

A. Control Module (figure 2).

The Control Module contains operating switches, a calibration potentiometer and a readout section. All operating controls and indicators are located on this module.

1. COMPUTER (Power) Switch. In the ON position, applies power to the system. In the OFF position, removes power from the system.

2. TIME and DIST. Information Control Switches. These toggle switches are SPDT break-before-make components. They are used to control the input of time and distance information into the Computer Module.

3. TIME and DIST. Reset Switches. These pushbutton switches are SPDT break-before-make components. The TIME reset pushbutton, when depressed, resets the time storage function of the Computer Module. The DIST. reset pushbutton (also referred to as System Reset), when depressed, resets the time, speed and distance sections of the Computer Module.

4. BRIGHTNESS (Dimmer) Control. This control is a 25 ohm, $12\frac{1}{2}$ watt rheostat used to control the intensity of display on the readout section. Varying the control clockwise increases the intensity of display.

5. Readout Section. This section displays the average speed (MPH) of the vehicle being clocked. It consists of 21 axial lead lamps that form the 3-digit numerals when illuminated, one T-1 lamp that forms the decimal point and another T-1 lamp (located at the upper left of the tens digit) which illuminates when the vehicle being clocked exceeds 100 MPH. When this lamp illuminates, 100.0 MPH must be added to the indicated speed.

6. Calibration Potentiometer. The CAL. potentiometer is a 20K ohm precision variable resistor with a resolution of less than 0.04%. This potentiometer is used to calibrate the system when daily calibration checks indicate a need. The adjustment screw is turned clockwise to lower the oscillator frequency which increases the readout speed indication and counter-clockwise to lower the indication.

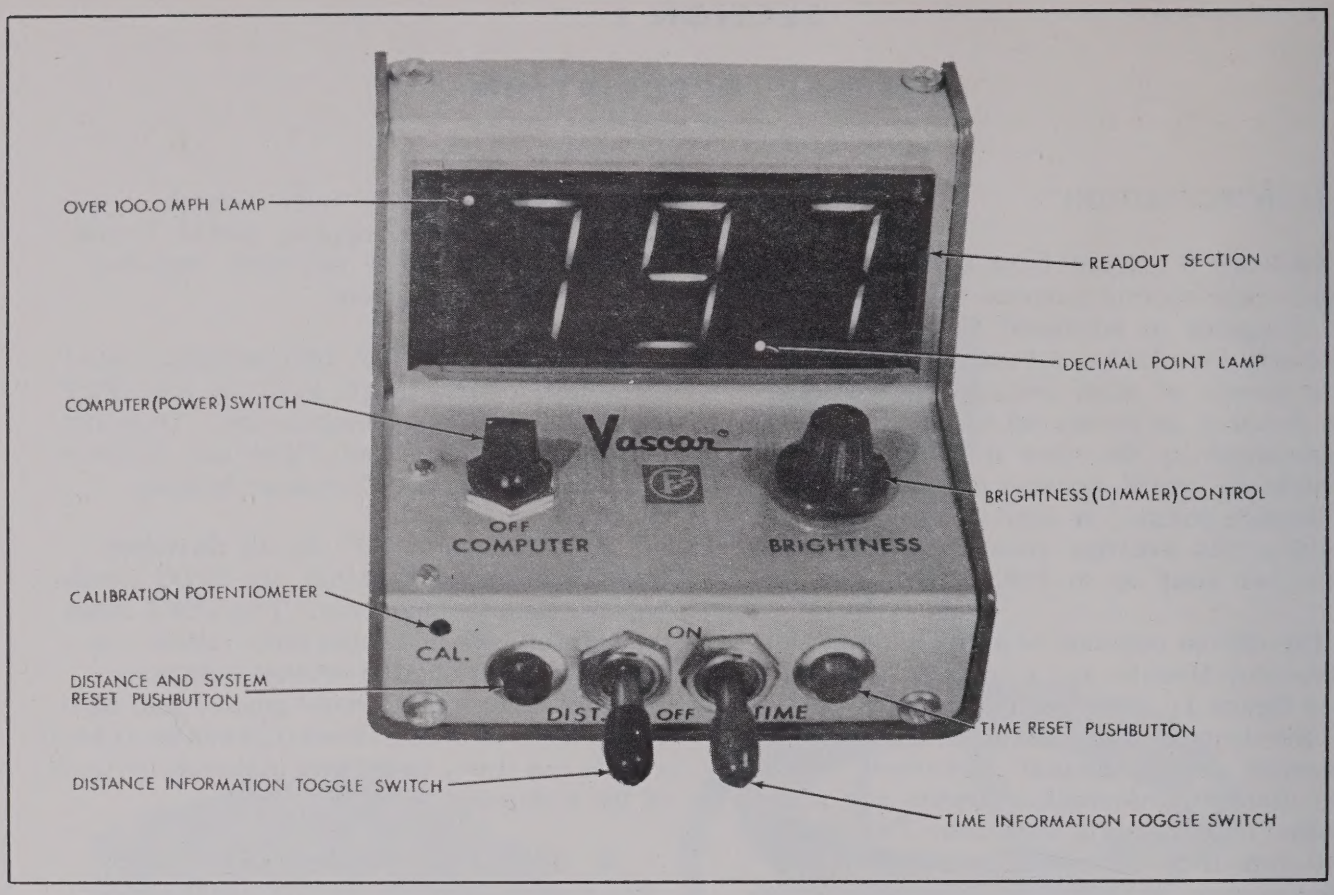


Figure 2. Control Module.

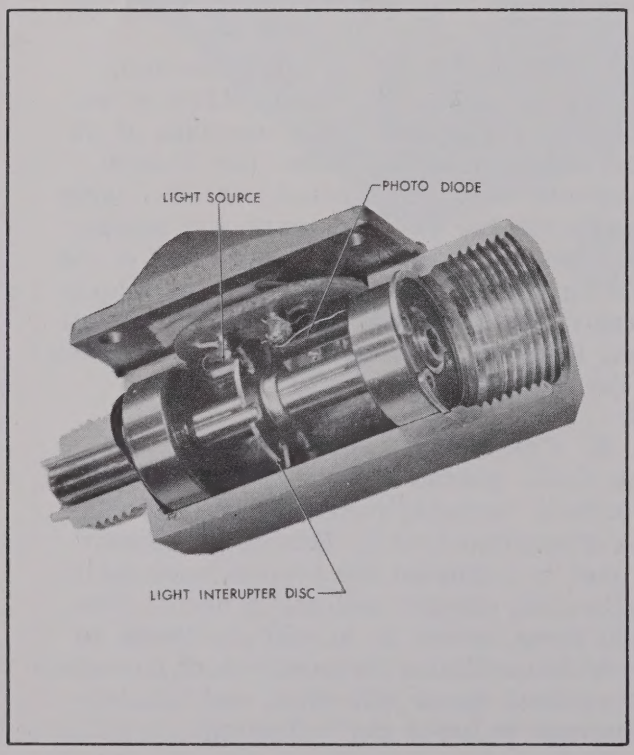


Figure 3. Cutaway View of Odometer Module.

B. Odometer Module (figure 3).

The Odometer Module is a photo pick-up device connected directly to the speedometer cable. It consists of a light source, photo diode, a light interrupter disc, and a suitable housing allowing mechanical connection to the vehicle transmission and speedometer cable. This module will provide a nominal 6000 pulses for each mile traveled by the vehicle. These pulses are coupled by a cable to the Computer Module distance information input.

C. Computer Module (figure 4).

The Computer Module consists of electronic circuitry capable of storing time and distance information used to accurately compute average velocity. It also contains an accurate time base (oscillator) and the necessary switching circuitry for the digital display. The circuitry is contained in a housing provided with plug-in receptacles for the power cable, Odometer Module, and Control Module.

D. Accessories (figure 5).

1. Mounting Stand. The mounting stand allows the Control Module to be mounted in a variety of positions within easy reach of the operator. Refer to Section IV for complete installation details.

2. Power Cable The power cable allows the application of vehicle power to all VASCAR II systems.

3. Calibration Tool. The calibration tool is used by the operator to adjust the CAL. adjustment screw on the Control Module.

4. Hardware Envelopes. Envelopes containing all mounting hardware and miscellaneous literature are provided with each module.

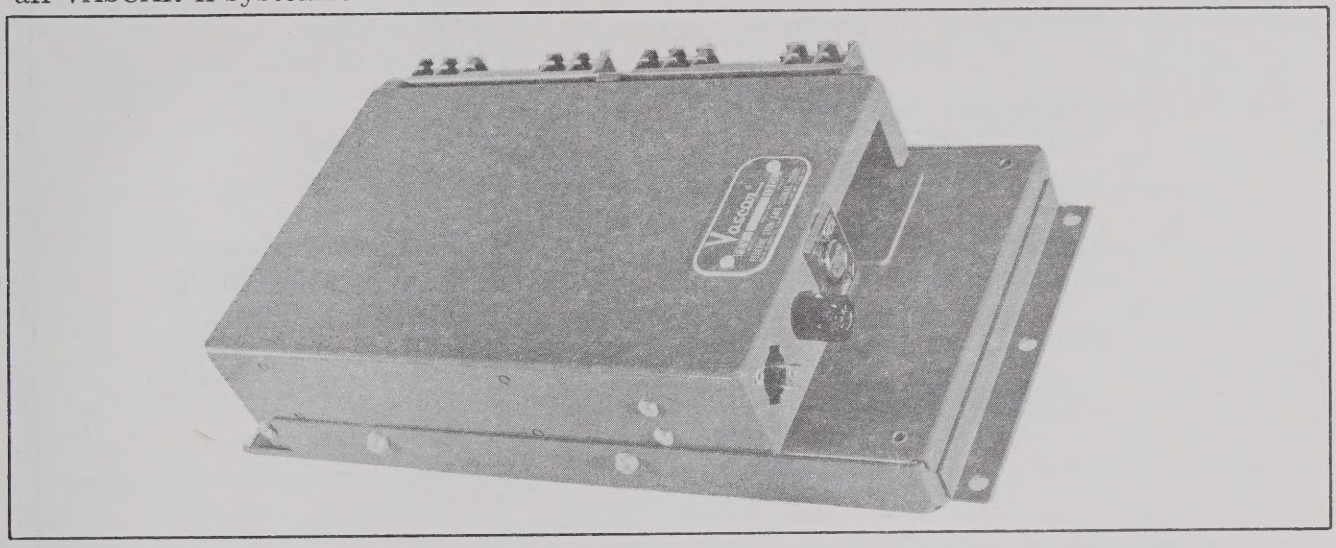


Figure 4. Computer Module.

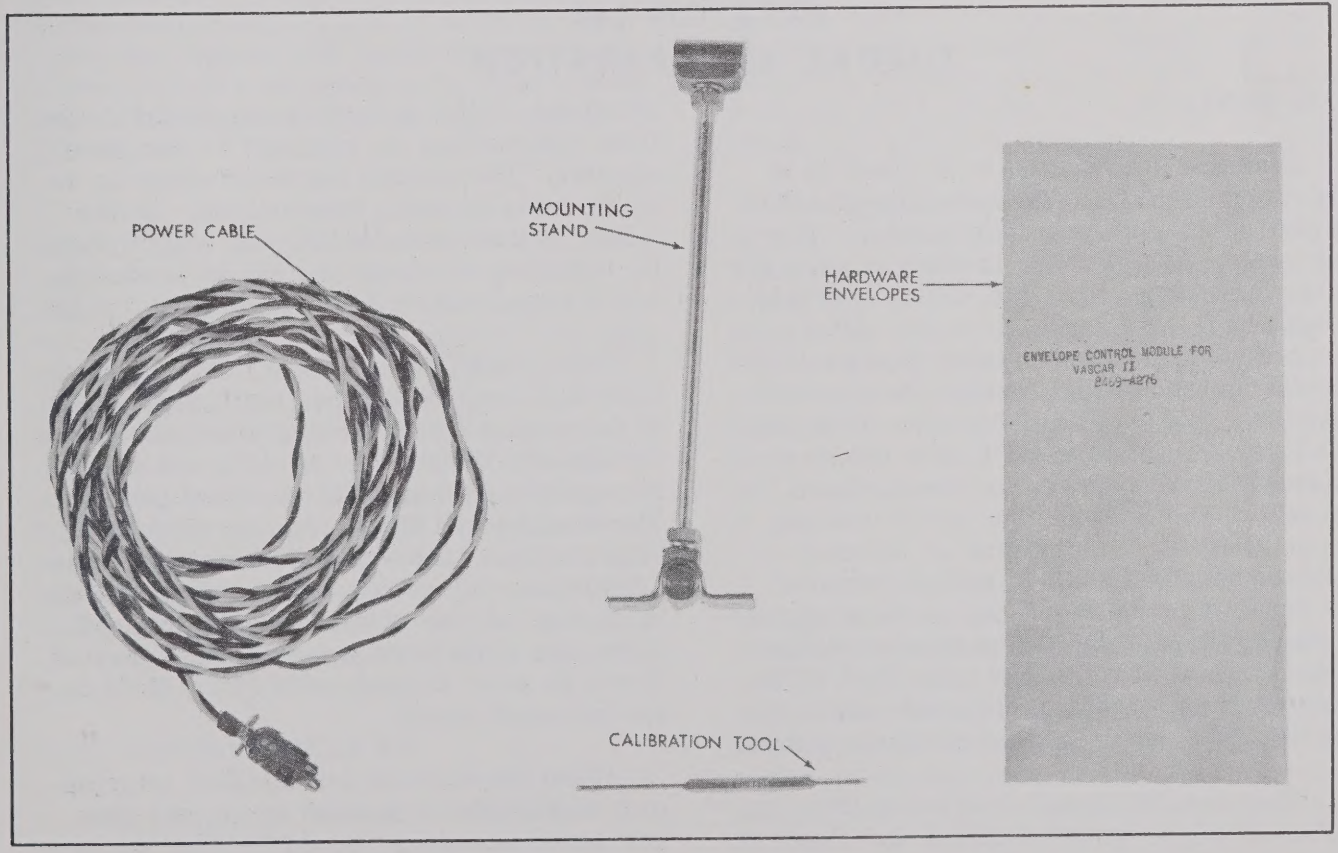


Figure 5. VASCAR II Accessories.

SECTION II

SPECIFICATIONS

A.	RANGE:	
	Speed	00.0 to 199.9 MPH
	Distance	$5\frac{1}{2}$ miles (nominal)
	Time	$6\frac{1}{2}$ minutes (nominal)
B.	POWER:	10 to 16.5 VDC 36 watts at 12 VDC
C.	TEMPERATURE:	
	Operating	$-20^{o}F$ to $+140^{o}F$
	Storage	$-67^{o}F$ to $+212^{o}F$
D.	ACCURACY:	Temperature coefficient less than $\pm$ 0.005% per ^{o}C
E.	WEIGHT:	13 pounds
F.	DIMENSIONS (HWD):	
	Computer Module	$2\text{-}5/8 \times 7\frac{1}{4} \times 13\frac{1}{2}$
	Control Module	3 x 4 x 5
	Odometer Module	1 x 1 x 3

NOTE: Data subject to change without notice.

SECTION III
THEORY OF OPERATION

3–1. GENERAL.

Distance information is obtained by a pick-up device (Odometer Module) attached to the vehicle speedometer cable. The Odometer Module will produce a pulse for every ten inches that the vehicle travels. Setting the DIST. switch to ON allows the distance information pulses produced by the Odometer Module to enter the distance counter in the Computer Module. After the DIST. switch is set to OFF, the distance information is retained in the distance counter. The system has provisions to accumulate up to $5\frac{1}{2}$ miles of distance information. If the DIST. switch remains ON for more than $5\frac{1}{2}$ miles, an error signal is produced which causes the readout section of the Control Module to display 00.1 MPH. This error signal may be cleared by depressing the DIST. reset pushbutton (black button).

When the TIME switch is set to ON, pulses from an internal 170.7 Hz clock enter the Computer Module time counter. After the TIME switch is set to OFF, the time information is retained in the time counter. The system can accumulate up to $6\frac{1}{2}$ minutes of time information. If the TIME switch remains ON for longer than $6\frac{1}{2}$ minutes, an error signal is produced which causes the readout to display 00.1 MPH.

After both TIME and DIST. switches have been set ON and then OFF, regardless of the sequence, the computer automatically divides the distance by the time and stores the speed information in the speed counter. The readout will display the speed counter information. The lamp in the upper left-hand corner of the readout indicates speeds in excess of 100 MPH when illuminated. When this lamp is illuminated, the operator knows he must mentally add 100.0 MPH to the indicated speed.

When the accumulated distance information is intended to be used again, the time and speed counters should be cleared by depressing the TIME reset pushbutton

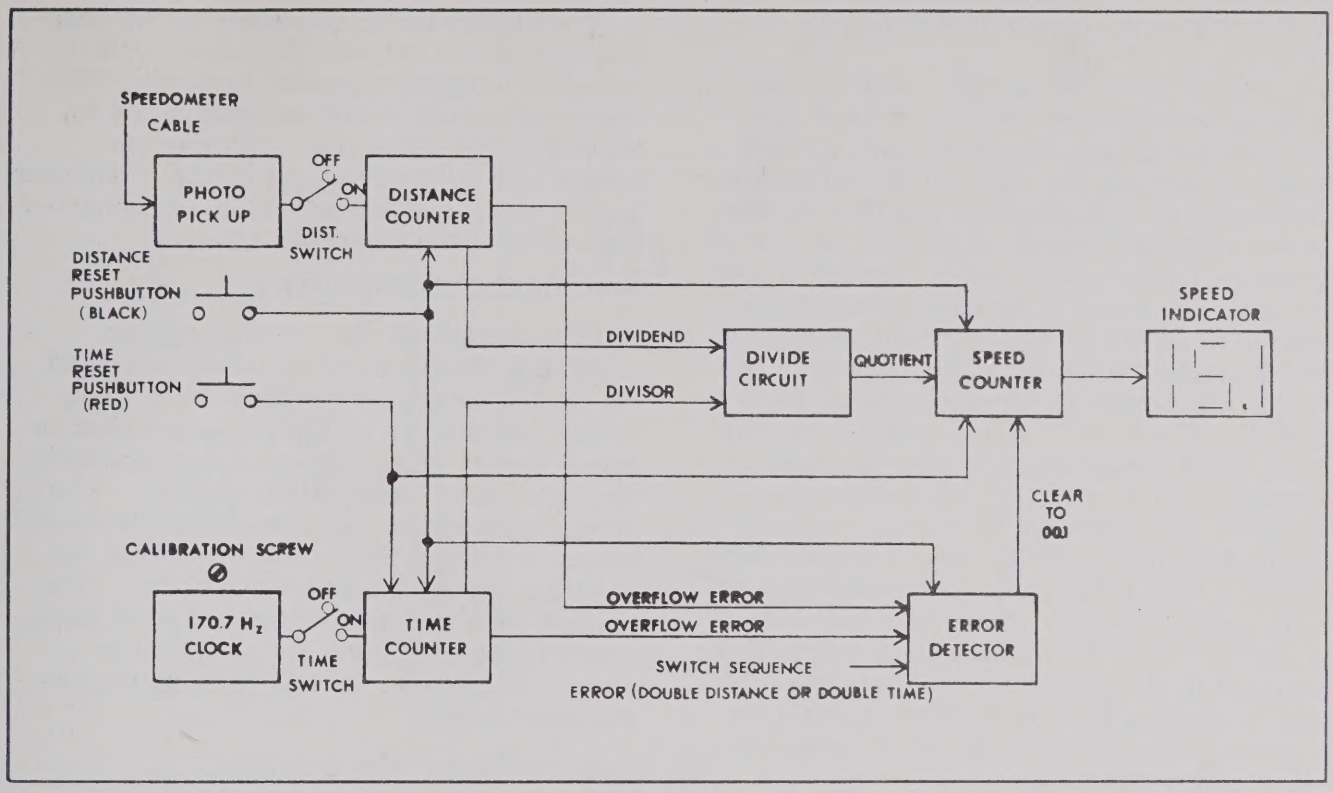


Figure 6. Block Diagram.

(red button). When the TIME switch is subsequently set ON and then OFF, the Computer Module will divide the previously stored distance information by the new time information and display the new speed information.

The DIST. reset pushbutton (black button) clears the distance, speed and time counters to zero and resets any error condition (00.1). If the TIME toggle switch is set ON and OFF and then ON again without depressing either the TIME or DIST. reset pushbuttons, an error signal will be produced which will cause the readout to display 00.1 MPH. If the DIST. toggle switch is set ON and OFF and then ON again without depressing the DIST. reset pushbutton, an error signal will be produced which will cause the readout to display 00.1 MPH. This error condition can only be cleared by depressing the DIST. reset pushbutton (black button).

3–2. ODOMETER MODULE.

The Odometer Module is an electro-mechanical device which produces a series of pulses, which are fed to the Computer Module distance counter. The pulse repetition rate is proportional to the rate of vehicle wheel rotation. Included in the Module is a light source (T-1 lamp), a light receiver (photo diode), and a notched wheel which acts as a light interrupter.

The light source (current drain 115 MA) directs a spot onto the tip of the photo diode, when the notched wheel is in a position to allow light passage. The light beam is alternately interrupted and passed as the notched wheel revolves on a shaft connected directly to the speedometer cable. The diode's resistance varies to allow a voltage drop of less than 1 volt when light is passed, and more than 4 volts when the light beam is blocked.

A six slot wheel, which supplies a nominal 6000 pulses per mile, is provided for the majority of automobiles which have speedometer cables turning at 1000 revolutions/mile. Some automobiles, including Oldsmobile and Volkswagon, have their speedometer cables revolving at approximately 750 revolutions/mile. These automobiles would use an Odometer Module with an eight slot interrupter wheel.

3–3. POWER DISTRIBUTION (figure 7).

Power from the positive side of the vehicle electrical system (10 to 16.5 VDC) is supplied to the Computer and Control Modules through the white wire, which must be connected directly to the positive battery post. With the Power switch in the ON position, input power flows through a five ampere fuse, 175°F thermostat and Power switch to all circuits. Power will be applied to all circuits as long as the temperature within the Computer Module case is below 175°F. The 175°F cut-out thermostat will open if the temperature within the case exceeds this point. The electronic components in the Computer Module are rated to operate within a -20°F to +167°F temperature range. This range will not be exceeded as long as the Computer Module is operated in a -22°F to +140°F environment. A thermister, encased in the oscillator oven, disables the unit by locking in a 00.1 error signal until a heater brings the oscillator to its operating temperature range.

The system (excluding the oscillator heater) normally draws two amperes. The oscillator heater adds a current requirement of up to 1.5 amperes. Therefore, the total current draw can be up to 3.5 amperes. Vehicle voltage is applied to the incandescent read-out lamps through a dimmer control. The dimmer control is a series element in the positive common leg of the lamps. Voltage is supplied directly to the control from the switched side of the Power switch. Full clockwise rotation provides minimum resistance and maximum lamp brightness. The number of lamps illuminated will vary according to the average speed display on the readout. The load increases as more lamps are illuminated. Because of this, the dimmer control will not provide uniform brightness under all conditions.

A +5 VDC regulating transistor is mounted on a heat sink on the outside of the computer case (away from connectors). The transistor is electrically insulated from the heat sink with a mica insulator. Shorting the transistor mounting screws to the heat sink or to the vehicle frame will damage the transistor. A regulator circuit provides a very stable 8.2 VDC to the 170Hz clock circuitry.

The black wire is connected to the negative side of the vehicle electrical system (must be a negative ground system). This black wire must be connected directly to the negative battery post. This is the return side of the read-out lamps, computer logic, clock, and heater; and also connected internally to the computer case.

3–4. READOUT CIRCUITRY.

The lamps in the readout section (excluding the decimal point) are switched on by the action of corresponding lamp driver transistors on the Computer Module speed board. When a lamp driver conducts, the associated lamp will illuminate. The driver transistors and associated circuitry cause a voltage drop of 1.5 volts in the negative leg of the lamp circuitry. The voltage drop across the decimal point lamp, which is the only lamp not activated by a driver transistor, is 1.5 volts more than the other lamps.

3–5. INFORMATION CONTROL.

Input information is controlled by the setting of the TIME and DIST. toggle switches. As long as the Power switch is set to ON, time information is continuously being generated by a 0.1% oscillator. The time pulse output of the oscillator is fed to one input of a NAND gate. The other input is controlled by the TIME toggle switch through a flip-flop.

As long as the VASCAR vehicle is in motion and the Power switch is set to ON, distance information is continuously being generated by the photo pick-up device in the Odometer Module. These distance pulses feed one input of a NAND gate. The other input is controlled by the DIST. toggle switch through a flip-flop.

A flip-flop, being a latching type component, will remain in a given state until set to the other state. Therefore, if an information toggle switch is slowly moved from the OFF position, where the common wiper is not in electrical contact with either switch contact, the flip-flop will remain off until electrical contact is established with the ON position. Similarly, the flip-flop will remain on as the switch is moved from ON through neutral. It will not turn-off until electrical contact is established with the OFF position.

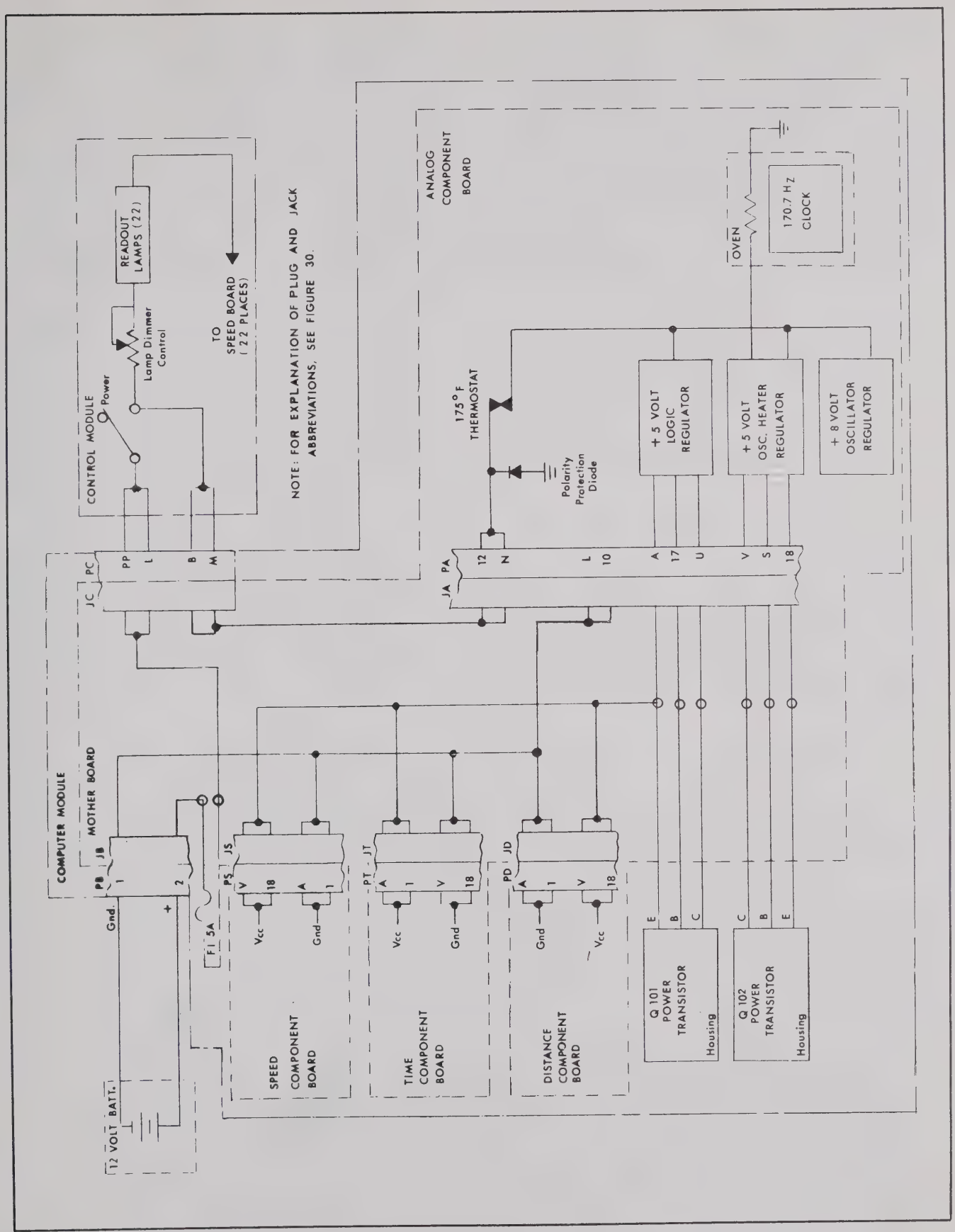


Figure 7. Power Distribution Diagram.

3–6. RESET CIRCUITRY.

The various computer sections are reset by depressing the reset pushbuttons. When a pushbutton is depressed, a ground potential (0.0 to 0.25 VDC) is applied to the applicable circuit reset leg. When the TIME pushbutton is depressed, the time storage register and computation register are reset to zero. The decoding section is also reset to a 00.0 condition, unless an error condition (00.1) exists. When the DIST. pushbutton is depressed, the time storage register and computation register are cleared (reset) through the TIME pushbutton wiring. The distance storage register and error condition (00.1) are reset simultaneously through a separate wire. A flip-flop, which feeds one input of a NAND gate, is set when the DIST. pushbutton is depressed. The other input of the NAND gate is controlled by a thermister in the oscillator oven. An error condition can't be cleared unless the thermister indicates that the oven is at operating temperature.

SECTION IV

INSTALLATION

4–1. GENERAL.

Because of the variation of automobiles between manufacturers, it is necessary to locate and install VASCAR as the particular situation requires. The standard installation (figure 8) is usually as follows:

1. Control Module and its mounting post above the transmission hump.

2. Computer Module either under the passenger side of the front seat or directly behind it.

3. Odometer Module usually at the vehicle transmission coupling or inside the firewall. However, the type of automobile will determine the location and installation (refer to paragraph 4-4).

NOTE

Whenever feasible, a two-piece speedometer cable should be ordered with new vehicles or installed on in-use vehicles. The use of a two-piece cable increases Odometer Module life and makes installation and servicing easier.

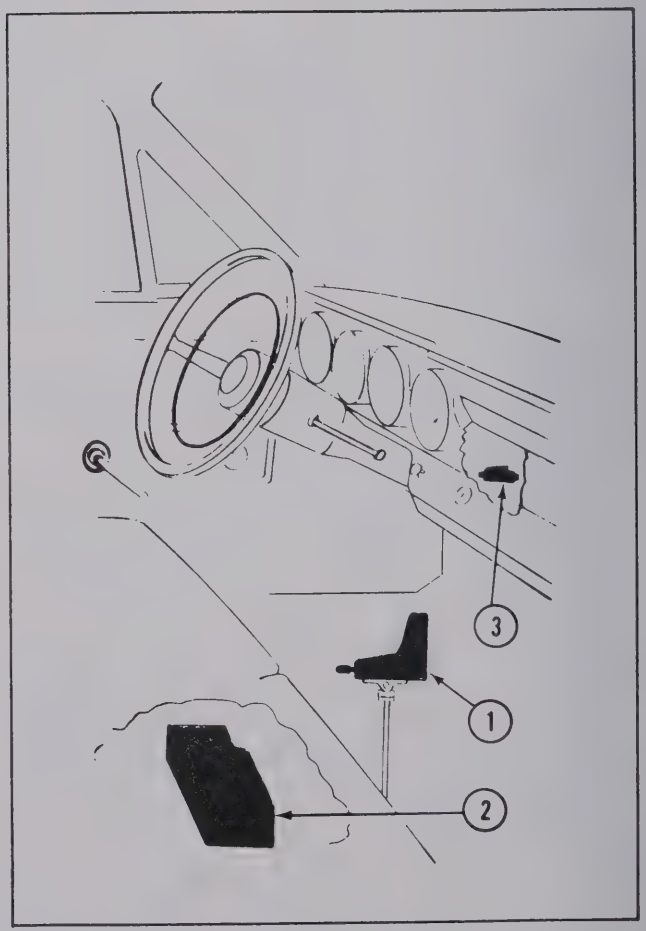


Figure 8. Typical Installation.

NOTE

All cables and wires from the modules should be placed under the floor mats and fed to the Computer Module located under or behind the front seat. By installing these cables under the floor mats, accidental tripping during entry or exit from the vehicle will be prevented.

4–2. CONTROL MODULE.

Supplied with each Control Module is an accessory kit containing hardware used for mounting the module in the vehicle. The enclosed hardware can be used to assemble mounting stands for either floorboard or dashboard mounting. The particular stand to be used will normally be dictated by the availability of a convenient mounting surface (sheetmetal) on the dashboard of the vehicle.

Two mounting rods, one straight (9-7/8 inches long) and the other with a 90^{o} bend are provided in the kit. The straight rod is normally used for floorboard mounting while the bent rod is used for dashboard installations. Figure 9 shows both basic installations.

A. Assembly of Mounting Stand to Module.

To assemble either mounting stand, proceed as follows:

NOTE

The numbers within the parentheses ( ) in the following steps refer to the index numbers in the Control Module parts list. The components are also shown by index number in figure 35.

1. Thread nuts (#8) on both ends of mounting rod (#9 or #10) as far back onto rod as possible.

2. Place lockwasher (#7) on rod at end that will be assembled to Module.

3. Place locking plate (#6), curved side up, onto module end of rod.

4. Slide pivot (#5) into opening of module mounting bracket (riveted to bottom of module). Center bracket so that tapped hole in pivot is in line with slot in mounting bracket.

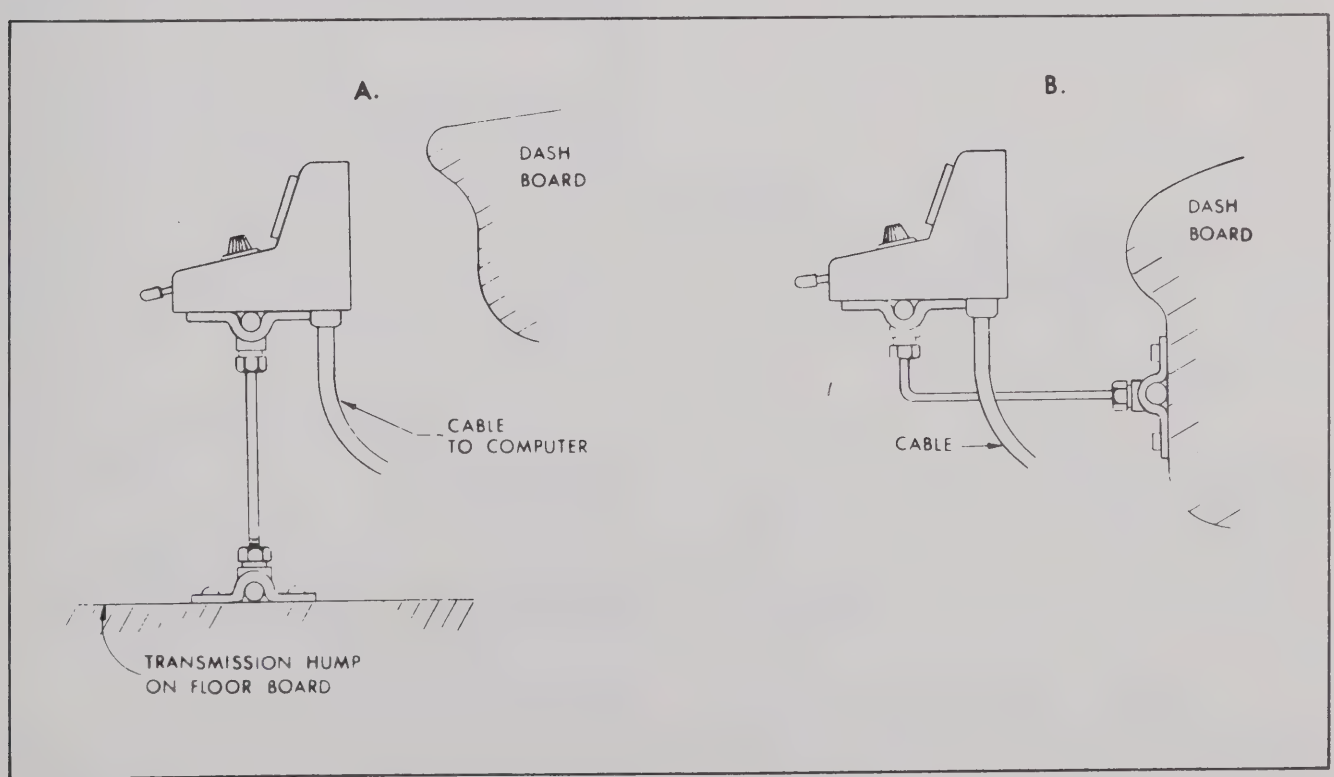


Figure 9. Control Module Basic Installations.

5. Thread mounting rod into tapped hole showing through slot. Assemble rod into module until the end of the rod prevents rotation of rod in the pivot. Back off one turn. Bring up nut until it begins to add bind to the rod movement.

6. Place lockwasher (#7) and locking plate (#6) on the other end of the rod.

7. Place mounting plate (#11) over rod and rest in the mating curved surface of the locking plate.

8. Thread pivot (#5) onto rod until end of rod is flush with bottom of tapped hole in pivot.

9. Thread nut (#8) down until it begins to add bind to rod movement.

NOTE

The pivot assemblies at either end of the rod provide approximately 90° rotation of the module along the slot. Also, the module can be rotated radially when located in a particular position along the slot. Tightening of the nuts, at both ends of the rod, will lock the module in any position along its allowed travel.

B. Floorboard Mounting.

1. Locate a convenient mounting position on the transmission hump for the Control Module and mounting stand (assembly). It should be positioned at a distance away from the dash which allows the operator the most convenient operation of Control Module controls (see figure 9A).

2. Place the assembly at the selected location on the transmission hump. Using the mounting plate as a template, scribe two positioning marks on the transmission hump.

3. Drill two holes at the positioning marks with a #8 (0.199 diameter) drill bit.

4. Install the assembly to the transmission hump with the two #14 x $1\frac{1}{2}$ inch long sheet metal screws (supplied).

5. Adjust the stand to the most desired operating position and tighten the locking nuts.

6. Run the Control Module cable back to the Computer Module and connect as shown in figure 12. If possible, run cable under floor mat and store excess cable in an area where it will not be stepped on or abused in any manner.

7. Insert the connector in the Computer Module receptacle. Lock in place using the knurled stud projecting from the connector cover.

C. Dashboard Mounting.

The mounting plate can be fastened to the dash with the centerline of its two mounting holes in either a horizontal or vertical position. If the unit is mounted with the plate horizontal (see figure 10D), the module can be pivoted from left to right at the dashboard pivot. At the same time, the unit can be tilted vertically at the pivot directly under the module. If the mounting plate is fastened vertically (see figure 9B) to the dash, both pivot joints will give vertical motion. The unit can be rotated horizontally at the pivot directly under the module to face the operator. Tightening of the nuts at both pivots will lock the unit into the desired position. After the method of mounting has been selected, proceed as follows:

1. Place the assembly at the selected location on the dash. Using the mounting plate as a template, scribe two positioning marks on the dashboard surface.

2. Drill two holes at the positioning marks with a #8 (0.199 diameter) drill bit. Take care not to damage wires located behind the dash.

3. Install the assembly to the dash with the two #14 x 3/4-inch long sheet metal screws (supplied).

4. Run the Control Module cable back to the Computer Module and connect as shown in figure 12. If possible, run cable under floor mat and store excess cable in an area where it will not be stepped on or abused in any manner.

5. Insert the connector in the Computer Module receptacle. Lock in place using the knurled stud projecting from the connector cover.

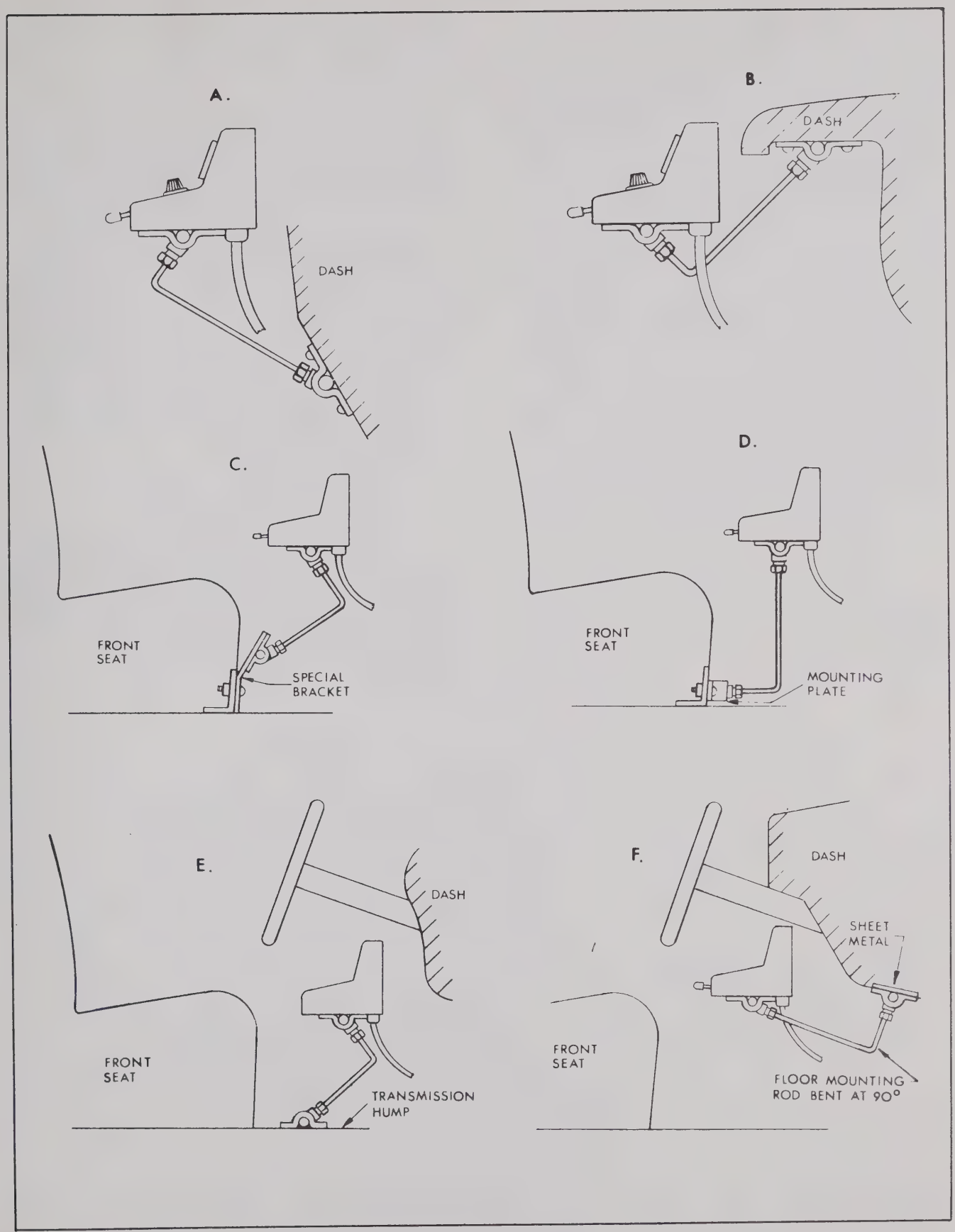


Figure 10. Control Module Modified Installations.

D. Mounting Modifications.

In some cases, primarily due to a particular dashboard configuration, it will be necessary to modify installation of the Control Module into the vehicle. The swivel arrangement at both ends of the stand makes possible a variety of mounting arrangements other than the two primary methods. A number of possible mounting configurations, using both the straight and bent mounting rods, are shown in figure 10. On the installation shown in figure 10C, the short length of the bent rod may make it necessary to fabricate a special bracket to mount to the seat frame. The horizontal long straight rod (figure 10D), normally used for a floor mount installation, has been altered (bent at 90^{o}) to provide direct mount to the seat frame. The installation shown in figure 10E illustrates the use of the dash mounting rod in a floor mount application.

4–3. COMPUTER MODULE.

A. Location Within the Vehicle.

The Computer Module is ordinarily installed in one of the positions shown in figure 11. When determining a location for mounting the Computer Module, the following factors should be taken into consideration:

1. Protection.

The computer should be installed in a position that affords the greatest protection from rain or snow that may be brought into the vehicle. It must never be installed in a position where the contour of the vehicle allows water to collect around the computer housing. Also, the computer should be located so that it is not subjected to physical abuse.

Failure to take the necessary precautions to prevent water from entering the computer housing could cause corrosive damage to the printed circuit boards and will VOID the warranty.

2. Heat Dissipation.

The finned, gold colored components located on the side of the computer are heat sinks. When the heat sinks are located where the maximum amount of air is allowed to circulate through them, maximum heat dissipation is achieved.

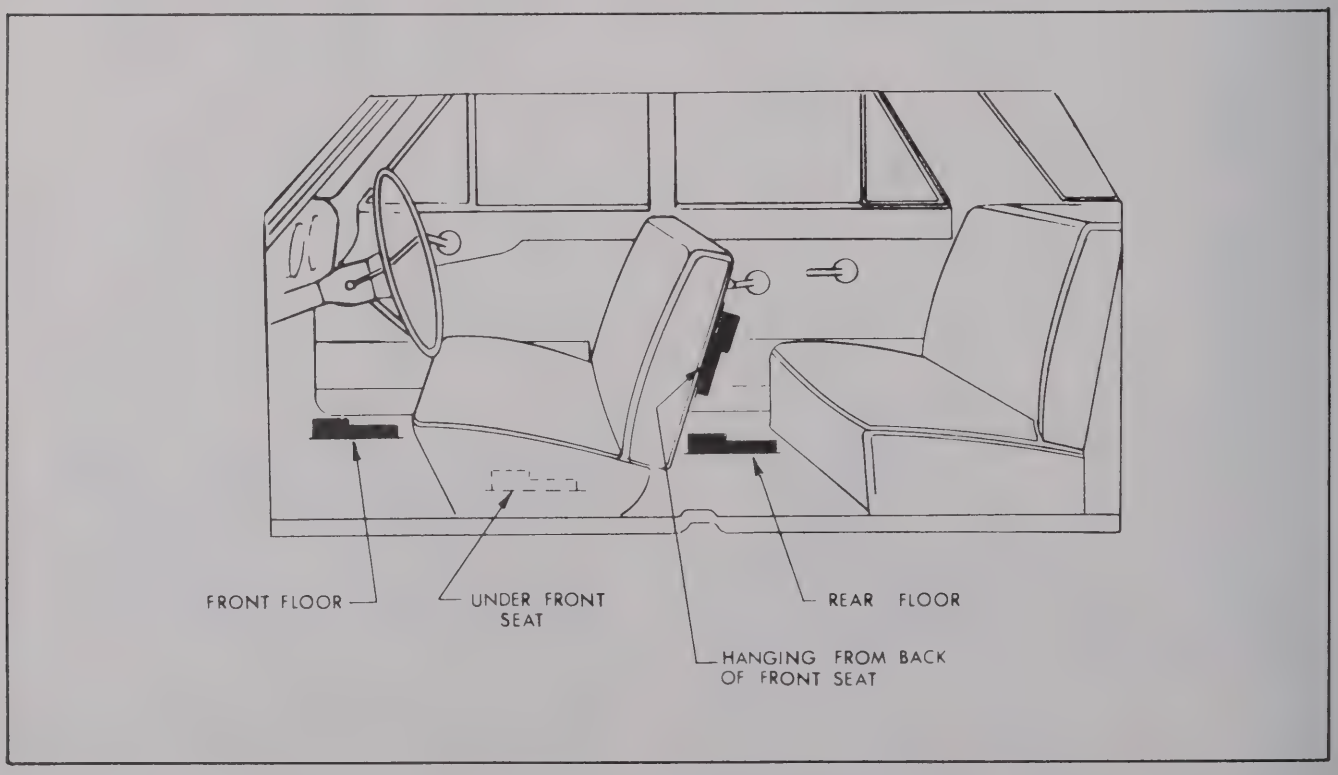


Figure 11. Computer Module Suggested Mounting Locations.

3. Accessibility of Connectors.

It is desirable to mount to computer in a location that allows the greatest access to the connectors and fuse. The end of the computer opposite the connectors is a cover for computer test points. If carefully installed, it would be possible to perform in-car testing if a system failure occurred.

B. Installation.

1. After the best location for the computer has been determined, scribe positioning marks of the computer mounting holes. Do not attempt to drill holes using the computer housing as a template. Damage to the housing caused by customer negligence will VOID the warranty.

2. Drill holes at the positioning marks using a #9 (0.196 diameter) drill bit.

NOTE

In many cases, it may not be possible to use all four mounting screws. In all cases, as many as practical should be used to provide a rigid mounting.

3. Install the unit using the #14 sheet metal screws, lockwashers and spacers (see figure 12). The computer housing must be grounded to the automobile sheet metal. The sheet metal screws will provide this ground when used with the lockwashers. To insure a good ground, scrape paint off the computer housing at the points where the lockwashers make contact with the housing. The spacers are necessary to provide heat dissipation and moisture evaporation, if necessary, from the underside of the computer.

4. After the computer is installed, the Odometer Module, Control Module, and power cable may be connected. It should be noted that each cable has a different type connector to eliminate any possibility of error. To install the power cable and Odometer Module connectors, push the connector into the proper plug until the connector locks into position. To connect the Control Module, position the connector in the plug and screw down the stud (clockwise).

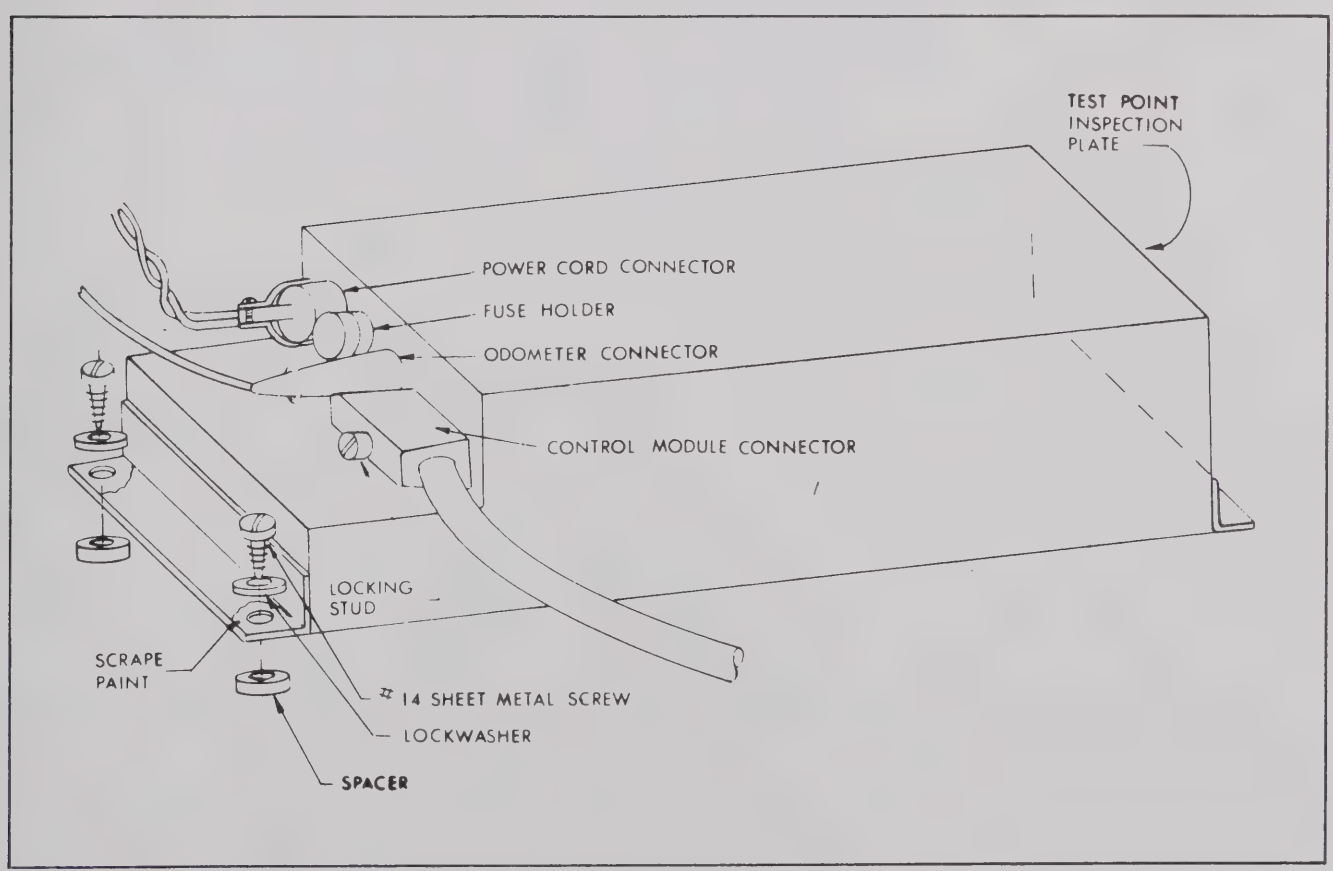


Figure 12. Computer Module Installation.

4–4. ODOMETER MODULE.

Because of the variety of automobiles, there are six basic types of Odometer Module fittings, mounting hardware etc. The make of vehicle will determine which of the following procedures will be performed.

A. Chrysler Products and All G.M., except Oldsmobile and Chevrolet.

The Odometer Module will be assembled at the transmission end of the speedometer cable. To install (see figure 13), proceed as follows:

1. Disconnect the speedometer cable from its transmission coupling by unscrewing the 7/8-inch nut.

2. Place a small amount of Permatex or other sealing material on the 5/8-18 threaded end of the Odometer Module housing and on the threads of the transmission coupling. Assemble the 5/8 to 7/8-inch adapter (supplied) to the Odometer Module (see figure 13A).

3. Insert the 1-3/8-inch long adapter (square ends) (supplied) into the Odometer Module at the end containing the 7/8-inch female thread (see figure 13B).

CAUTION

When installing the Odometer Module, insure that the Odometer Module, speedometer cable and power cable are at least one inch from the exhaust pipe.

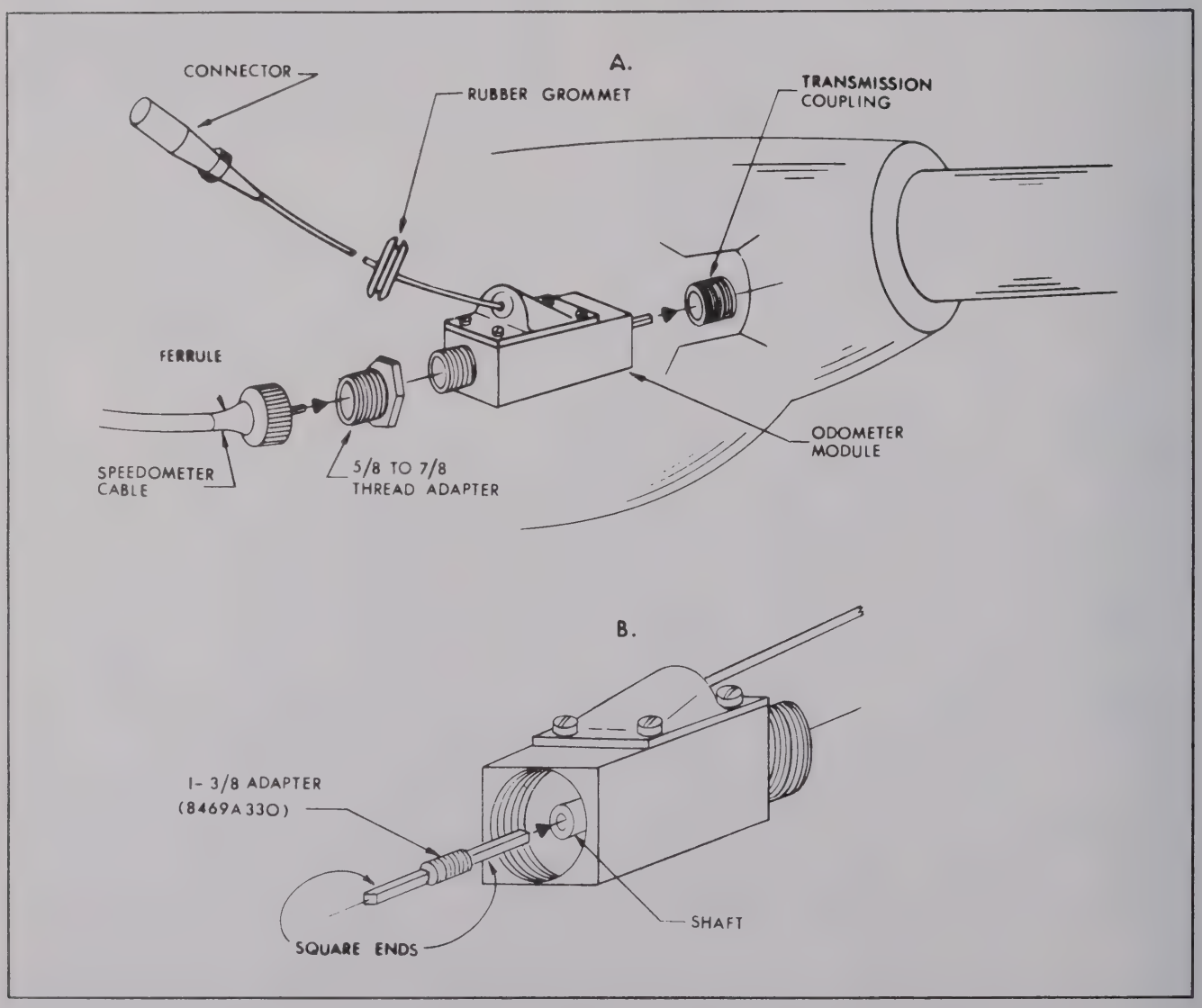


Figure 13. Odometer Module Installation on Chrysler Products and All G.M., Except Oldsmobile and Chevrolet.

4. Install the Odometer Module to the transmission coupling as shown in figure 13A. Insure that the 1-3/8 inch long adapter is inserted into its female fitting on the inside of the transmission coupling.

5. Connect the free end of the speedometer cable to the Odometer Module as shown in figure 13A.

IMPORTANT NOTE

For proper installation, the end of the ferrule must "butt" against the adapter before tightening the ferrule nut.

6. The Odometer Module power cable should be brought into the passenger compartment at the closest practical opening. Inspection plates, under the car, are one possible source of entrance. If an opening cannot be found, it will be necessary to drill a hole in the automobile body sheet metal as close to the Odometer Module as possible. Drill a one-inch diameter hole at the selected location. Feed the connector and cable through the hole and insert the rubber grommet (assembled on cable) to seal the opening.

7. Run the cable to the Computer Module and connect as shown in figure 12.

B. Chevrolet.

The Odometer Module will be assembled at the transmission end of the speedometer cable. To install (see figure 14), proceed as follows:

1. Disconnect the speedometer cable from its transmission coupling by unscrewing the 7/8-inch nut.

2. Place a small amount of Permatex or other sealing material on the threads of the transmission coupling. Install the 12-inch long extension cable (supplied) to the transmission coupling. Insure that the square end of the extension core mates with its female fitting on the inside of the transmission coupling.

3. Place a small amount of Permatex or other sealing material on the unconnected end of the Odometer Module. Bring the free end of the extension cable to either side of the automobile frame cross-member and connect to the Odometer Module. For proper connection the end of the ferrule must "butt" against the threaded fitting of Odometer Module before tightening the ferrule nut.

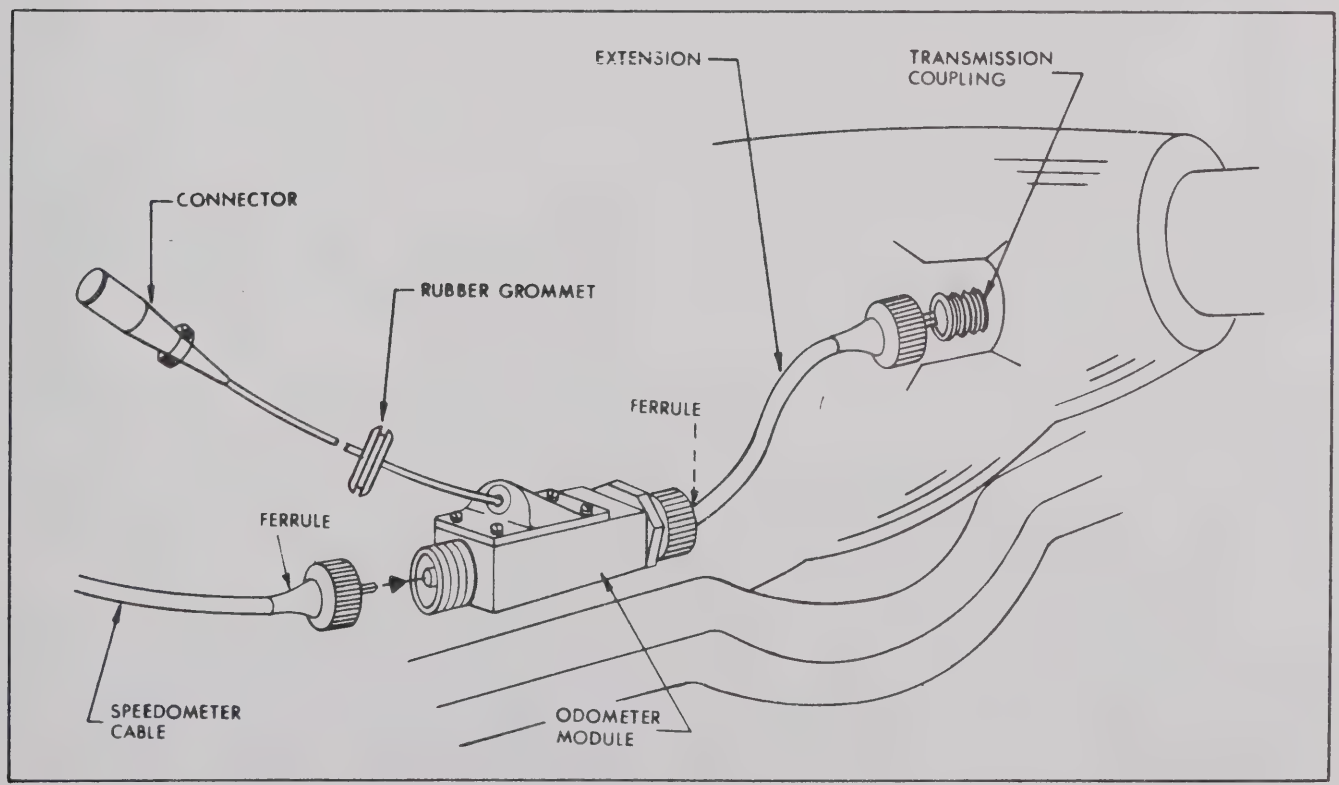


Figure 14. Odometer Module Installation on Chevrolet.

4. Remove the clamp used to secure the speedometer cable. Connect the free end of the speedometer cable to the Odometer Module. For proper connection, the end of the ferrule must "butt" against the threaded fitting of the Odometer Module before tightening the ferrule nut.

NOTE

Sharp bends should not be made in the speedometer cable when running it to the Odometer Module. A bend with a radius of less than six inches, at any one place in the speedometer cable, may cause binding and erratic speedometer operation. In many cases, it will be necessary to reposition the cable to prevent binding. Use the clamps (provided) to fasten the cable to its new position. In some cases, the existing cable will be found to be too long due to the added length of the Odometer Module. The excess should be taken up by forming a loop at the engine side of the firewall. In other cases, it may be necessary to feed a portion of the speedometer cable through the rubber boot at the firewall.

5. The speedometer cable should be secured to the vehicle with the supplied clamps (2). Drill a 1/8-inch diameter hole in the vehicle sheet metal at the desired clamp position. Place the cable in the clamp, and secure with #10 sheet metal screws (supplied).

NOTE

If possible, position one of the clamps approximately four inches from the Odometer Module. This will prevent the module from bouncing against the body sheet metal.

6. The Odometer Module power cable should be brought into the passenger compartment at the closest practical opening. Inspection plates, under the car, are one possible source of entrance. If an opening cannot be found, it will be necessary to drill a hole in the automobile body sheet metal as close to the Odometer Module as possible. Drill a one-inch diameter hole at the selected location. Feed the connector and cable through the hole and insert the rubber grommet (assembled on cable) to seal the opening.

CAUTION

Insure that the Odometer Module, speedometer cable and power cable are at least one inch from the exhaust pipe.

7. Run the cable to the Computer Module and connect as shown in figure 12.

C. Oldsmobile.

The Odometer Module is supplied with a special two piece cable which must be used in place of the existing speedometer cable. To install, proceed as follows:

1. Remove the old speedometer cable by performing the following steps:

NOTE

On some special installations the odometer cable is driven by the transmission. If this is the case, contact the factory.

a. Loosen the hexagon fitting at the left front wheel. Pull the speedometer cable free of the wheel.

b. Disconnect the cable at the speedometer by reaching behind the dash with a screwdriver and depressing the tang of the spring clip which holds the cable to the speedometer. Pull the cable free of the speedometer.

c. Push out the rubber grommet assembled to the firewall. Remove the entire speedometer cable.

2. Place a small amount of Permatex or other sealing material on the male threads at both ends of the Odometer Module.

3. Connect the Odometer Module to the two piece cable as shown in figure 15. For proper connection, the ends of both ferrules must "butt" against the threaded fittings of the Odometer Module before tightening the ferrule nuts. Place the rubber grommet, previously removed from the firewall, over the top end of the two piece cable.

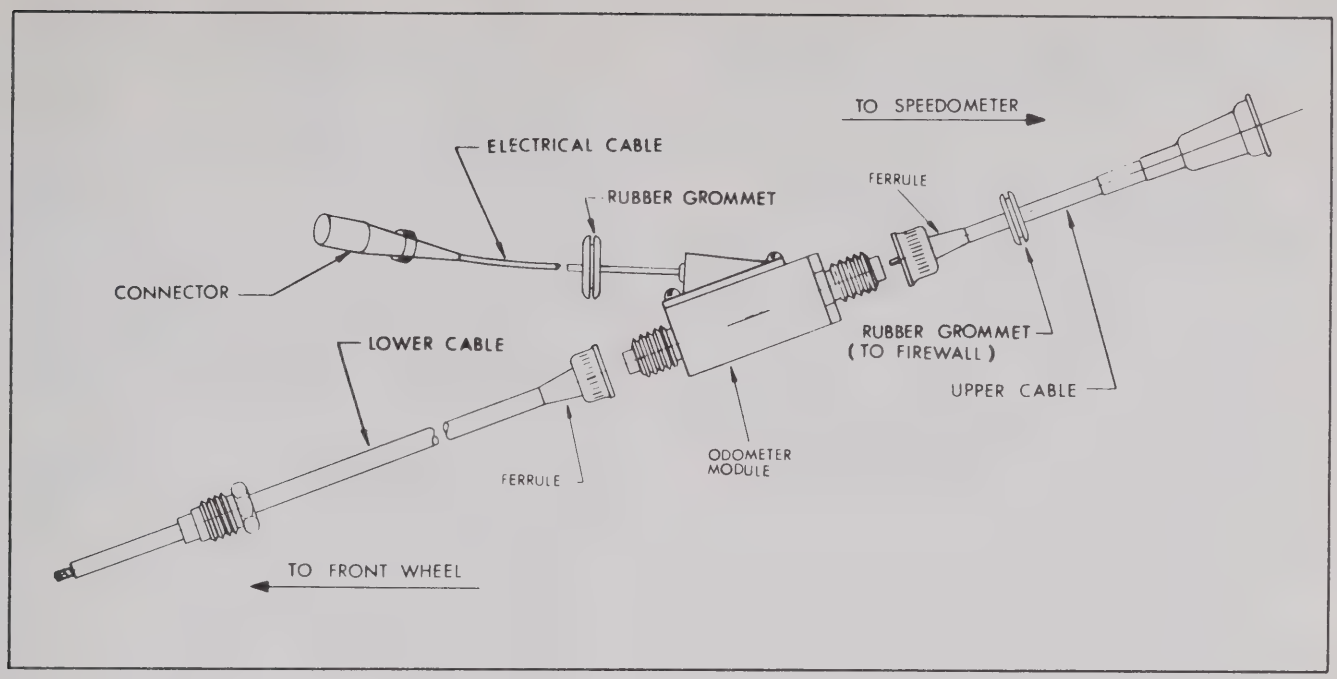


Figure 15. Odometer Module Installation on Oldsmobile.

4. Push the top end of the cable through the firewall from the engine compartment. Connect the top end of the cable to the speedometer.

5. Connect the lower end of the cable to the left front wheel.

6. Replace the speedometer cable grommet at the firewall.

7. The Odometer Module power cable should be brought into the passenger compartment at the closest practical opening. If an opening cannot be found, it will be necessary to drill a hole in the automobile body sheet metal as close to the Odometer Module as possible. Drill a one-inch diameter hole at the selected location. Feed the connector and cable through the hole and insert the rubber grommet (assembled on cable) to seal the opening.

8. Run the cable to the Computer Module and connect as shown in figure 12.

D. Ford Products (Transmission Mount).

The Odometer Module will be assembled at the transmission end of the speedometer cable. To install, proceed as follows:

1. Disconnect the speedometer cable at the transmission by unscrewing the bracket bolt. The cable can then be removed from the transmission by twisting slightly and, at the same time, pulling outward.

2. Remove the plastic gear from the plug end of the cable. The gear is held on with a spring clip. Place the gear in position on the plug (supplied). Lock into position with the spring clip (see figure 16).

3. Install the adapter (square on both ends) into the plug (see figure 16). Insure that the inserted end engages the plastic gear.

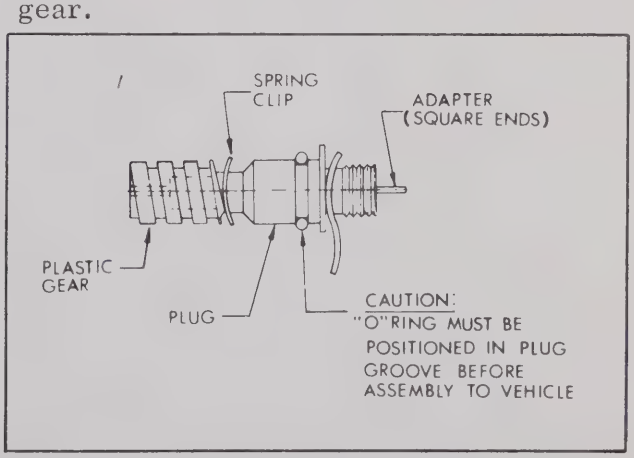


Figure 16. Adapter Installation.

4. Place a small amount of Permatex or other sealing material on the male threads of the plug and Odometer Module.

CAUTION

Insure that "O" ring is positioned in plug groove prior to assembly to vehicle.

5. Assemble the plug, Odometer Module and adapter as shown in figure 17.

6. Connect the loose end of the speedometer cable into the free end of the adapter. Lock into position with the set screw on the side of the adapter (see figure 17).

7. The Odometer Module power cable should be brought into the passenger compartment at the closest practical opening. Inspection plates, under the car, are one possible source of entrance. If an opening cannot be found, it will be necessary to drill a hole in the automobile body sheet metal as close to the Odometer Module as possible. Drill a one-inch diameter hole at the selected location. Feed the connector and cable through the hole, and insert the rubber grommet (assembled on cable) to seal the opening.

8. Run the cable to the Computer Module and connect as shown in figure 12.

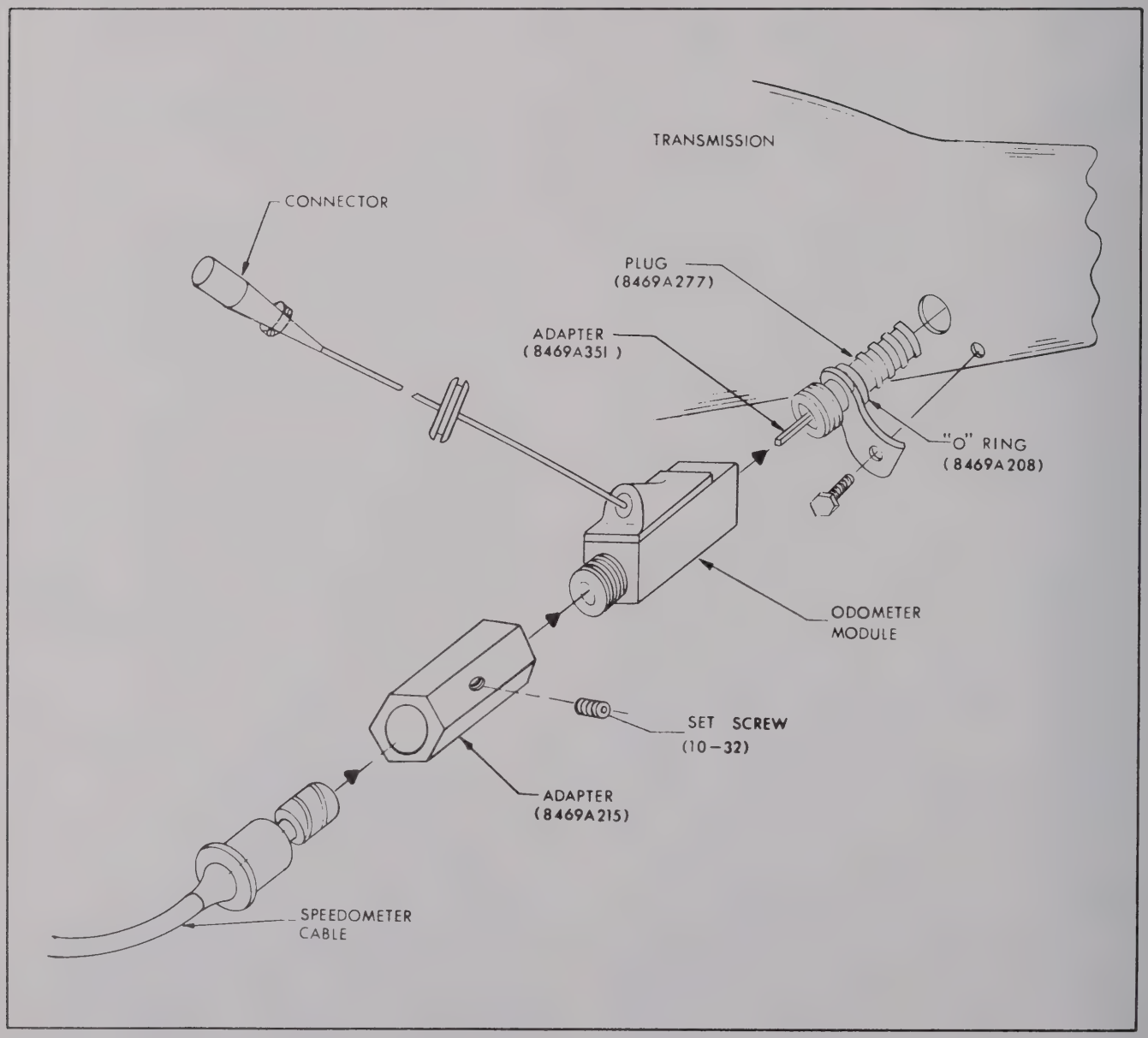


Figure 17. Odometer Module Installation on Ford Products (Transmission Mount)

E. Ford Products Equipped with Two-Piece Speedometer Cable.

The Odometer Module is mounted in place of the Emission Control Sensor on Ford Motor Co. products equipped with a two-piece speedometer cable. To install, proceed as follows:

1. Locate the sensor on the firewall of the engine compartment. Disconnect the upper and lower speedometer cable from the sensor. Unscrew the nut used to secure the sensor to the mounting bracket (see figure 18). Remove the sensor.

NOTE

The nut used to secure the sensor to the mounting bracket is not used when installing the Odometer Module.

2. Position the Odometer Module through the hole in the bracket. Connect the lower speedometer cable to the Odometer Module and tighten the cable ferrule nut (see figure 19). For proper installation, the end of the ferrule must "butt" against the threaded fitting of the Odometer Module before tightening the ferrule nut.

3. Connect the upper speedometer cable to the Odometer Module and tighten the cable ferrule nut. For proper installation, the end of the ferrule must "butt" against the threaded fitting of the Odometer Module before tightening the ferrule nut.

4. The Odometer Module power cable should be brought into the passenger compartment at the closest practical opening. If an opening cannot be found, it will be necessary to drill a hole in the automobile body sheet metal. Drill a one-inch diameter hole at the selected location. Feed the connector and cable through the hole and insert the rubber grommet (assembled on cable) to seal the opening.

5. Run the cable to the Computer Module and connect as shown in figure 12.

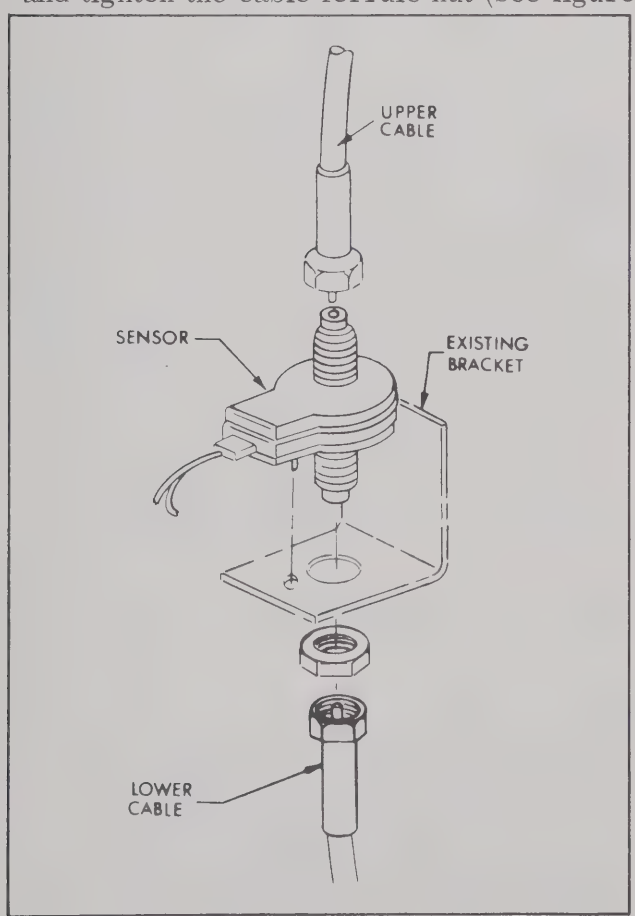


Figure 18. Sensor Removal.

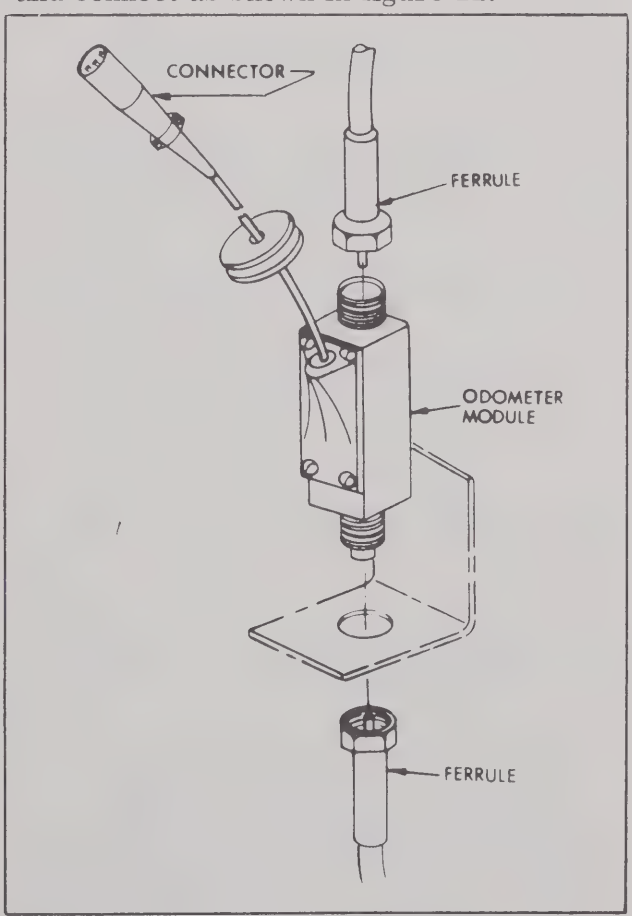


Figure 19. Odometer Module Installation on Ford Products (Two-Piece Cable).

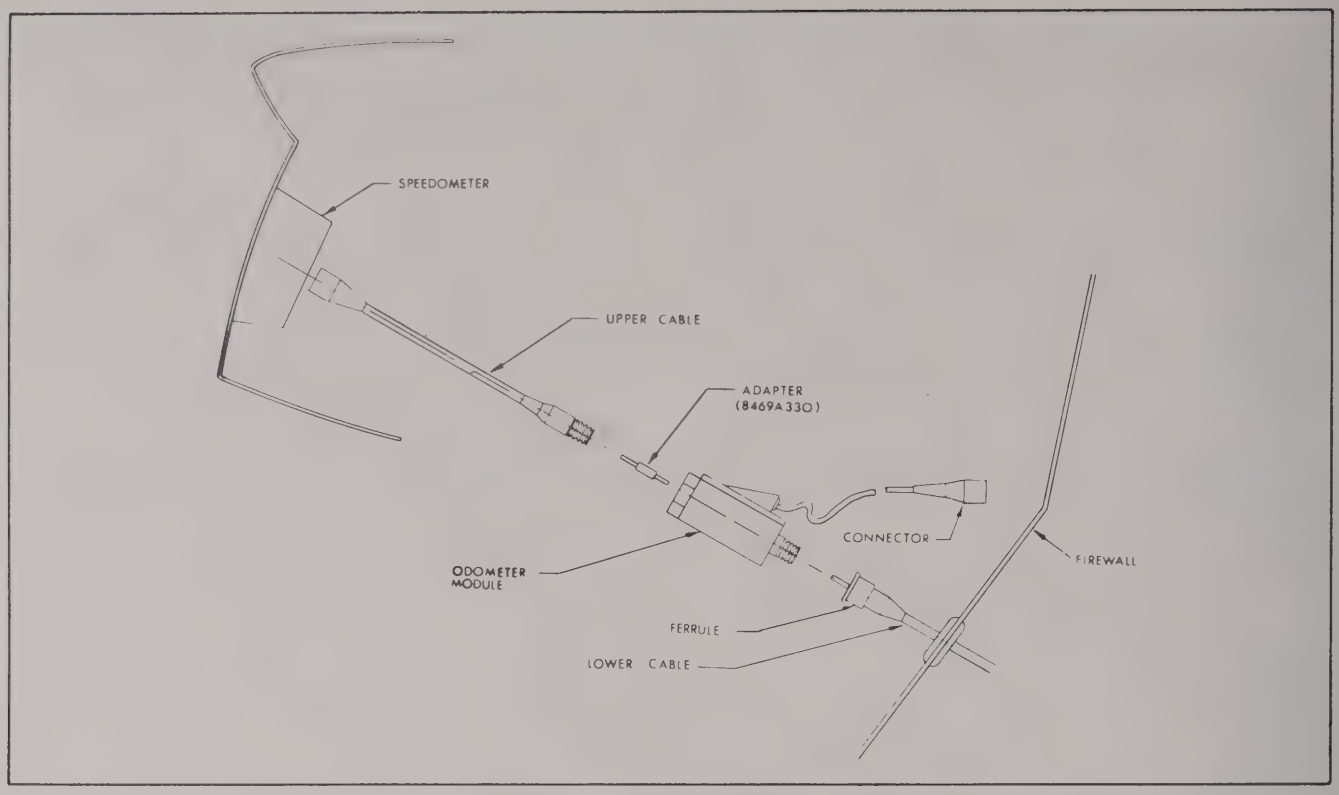


Figure 20. Odometer Module Installation on Chrysler Products (Two-Piece Cable).

F. Chrysler Products Equipped with Two-Piece Speedometer Cable.

The Odometer Module is mounted at the junction point of the two-piece speedometer cable. To install, proceed as follows:

1. Disconnect speedometer cable at the junction of the upper and lower section.

2. Insert the adapter (supplied) into the loose end of the upper cable section as shown in figure 20.

3. Connect the upper speedometer cable to the Odometer Module as shown in figure 20.

4. Connect the lower speedometer cable to the free end of the Odometer Module and tighten the ferrule nut.

IMPORTANT NOTE

For proper installation, the end of the ferrule must "butt" against the threaded fitting of the Odometer Module before tightening the ferrule nut.

5. Connect the Odometer Module power cable to the Computer Module as shown in figure 12.

4–5. POWER CABLE.

The white lead of the power cable should be connected to the positive battery terminal (see figure 21). The black lead should be connected to the negative battery terminal. When routing the cable to the battery, follow existing electrical wiring through the firewall and into the engine compartment. It is imperative that the cable not be routed within six-inches of automotive contact points, spark plugs and all solenoids.

The power cable should be placed under the front floor mat and fed to the Computer Module. Connect as shown in figure 12.

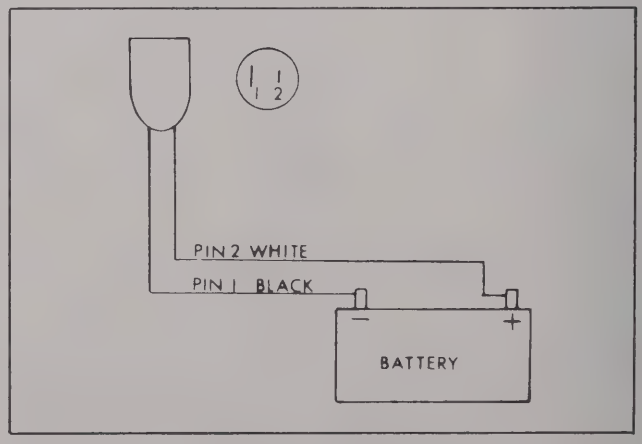


Figure 21. Power Cable Installation.

SECTION V

SERVICE AND MAINTENANCE

5–1. WARRANTY.

A. Limits of Liability.

Your Federal VASCAR II system has been carefully inspected and is guaranteed against defects of workmanship or material for a period of one year. Federal Sign & Signal Corp. will assume liability for parts and labor on Computer Module component boards for a period of one year. Computer Module component boards will be replaced without charge for a period of three years - labor not included. Federal Sign and Signal Corporation will be sole judge of what constitutes defective workmanship or material. For your VASCAR to be subjective to guarantee, you must comply with conditions and instructions regarding same as noted below.

This guarantee will not apply to any repairs made without our authorization. It will not apply under conditions contrary to our instructions and terms. It will be void if examination discloses tampering, unauthorized disassembly, misuse, or damage from external causes.

Defects of workmanship and material under this guarantee will be corrected at no cost to you, with the above exception, for labor and material. For the guarantee to become effective and a matter of record, the prepaid postcard included in shipping carton must be completed and mailed to us within ten days from receipt of your VASCAR.

B. Instructions for Return of Equipment for Repair.

To claim adjustment under the terms of our guarantee, you must comply with the following:

WRITE to the Regional Sales Office, giving the MODEL and SERIAL NUMBER of your VASCAR unit. DESCRIBE briefly, but completely, what your difficulty seems to be. The Regional Sales Office will give you the name and address of the nearest Authorized Service Center and other shipping instructions.

DO NOT SHIP the unit to us WITHOUT the Regional Sales Office's permission and shipping instructions. Please follow the above instructions. Correct description of your VASCAR functional problem may eliminate need for its return and the attendant "out of service" time. It also will have direct bearing on the destination to which we may advise you to ship.

Unauthorized returns will be held, pending disposition, at sender's liability for any expenses involved. If returned units are deemed in need of repairs not subject to guarantee, and such repairs have not been authorized by the sender, we will estimate repair extent and cost and notify the sender. Such authorized repairs and return will be at sender's expense.

ALL MATERIAL SENT TO US
MUST BE PREPAID

The Federal VASCAR computer is a fully transistorized digital computer. As such it is a precision instrument designed and manufactured for long dependable duty. The companion modules were designed with a minimum of moving parts and are composed of parts which reflect the latest technological advances. The VASCAR deserves reasonable care in handling and should not be abused or treated carelessly.

5–2. CALIBRATION.

For calibration procedures, refer to VASCAR II Operators Training Manual, Page 49.

5–3. TROUBLESHOOTING TECHNIQUES.

When troubleshooting the VASCAR system, it is recommended that the defective module be first isolated. Table 5-1 lists possible symptoms of malfunction, checks to be performed, and corrective action to

take. After the malfunctioning module has been determined, refer to the specific troubleshooting procedure for that module.

The fastest method of determining which module is causing an overall system failure is to substitute a known good module for a suspected defective module. Since it is not always practical to stock spare modules, a comprehensive troubleshooting procedure for each module is included in this section. However, the troubleshooting procedures cannot act as a substitute for logical interpretation of malfunction results as reported by the VASCAR operator and verified by the service technician. It is therefore strongly recommended that the technician read and understand Section I, General Description and Section III, Theory of Operation.

Some important points to consider when troubleshooting the VASCAR system are mentioned below.

A. All instructions must be read thoroughly before troubleshooting.

B. Use substitution wherever possible.

C. Disconnect power cable before removing, inserting or attaching meter or oscilloscope leads. The power cable should also be removed before removing or installing modules or component boards. Use extreme care to insure that adjacent contacts or connectors are not inadvertently shorted.

D. Remove all jumpers or other connectors before returning modules to service.

E. Make all checks within a given troubleshooting procedure in the order described. Stop when a failure is found and repair it before continuing.

F. Care must be taken to insure that the Control Module, Odometer Module and power cable connectors are handled carefully when connecting to the Computer Module. Aligning or connecting pins should not be damaged. Connectors should never be forced into place as a bent pin on a connector could damage its mating connector. The Power switch should be set to OFF prior to connecting or disconnecting connectors.

G. In general, the trouble will first be traced to one of the three basic modules by substituting a known good spare for the suspected defective component. If it is determined that the failure is in the Computer Module, further substitution of known good spare boards within the module should be made. (See paragraph 5-8 for details.)

IMPORTANT

Replacement of individual parts on the printed circuit boards, i.e., transistors, resistors, integrated circuits, etc., will void the Manufacturer's Warranty on that board during the warranty period.

H. Central Repair Stations can be set up with trained personnel and a minimum number of spares. Personnel already trained to service Two-Way Radio equipment can easily repair the VASCAR system, if the procedures outlined in this manual are followed.

I. Defective modules or printed circuit boards, within warranty, may be shipped prepaid back to the factory for repair or replacement. Parts out of warranty will be repaired for a nominal charge. (Refer to paragraph 5-1B, "Instructions for Return of Equipment for Repair".)

NOTE

Printed circuit boards must be shipped in approved protective containers provided by Federal Sign and Signal Corporation.

J. The Central Repair Station may find it expeditious to handle the replacement of individual parts. In this case, special attention should be given to personnel to make sure they are qualified to handle state of the art repair of printed circuit boards and are equipped with the proper tools.

K. When ordering replacement parts, specify each item. All replacement parts are individually stocked.

5–4. SCHEMATIC SYMBOLS.

A. Connectors.

1. Jacks. Jacks will be abbreviated J. The letter "J" will always be followed by another letter which designates the module or subassembly that will be plugged into that jack (see figure 30 for a complete list). The combination of the two letters will be followed by a dash and then a number or letter. The number or letter designates the individual pin or terminal on the jack:

Example: JS-2
J indicates jack
S indicates speed board
2 indicates terminal 2

2. Plugs. Plugs will be abbreviated P. The complete plug designation is similar to that of jacks, described above.

Example: PS-2
P indicates plug
S indicates speed board
2 indicates terminal 2

Note: This plug mates with JS-2 in example 1, above.

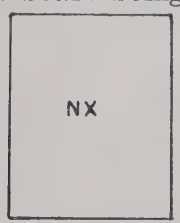
B. Test Points.

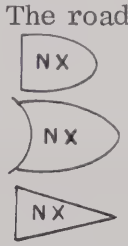
C. Lamp Driver.

See speed board schematic diagram for configuration.

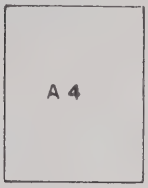
D. Integrated Circuits.

Any letter-number combination appearing within one of the integrated circuit symbols indicates its position on the board being checked. The road map



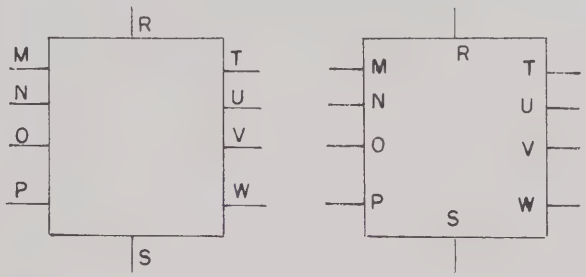


style boards are clearly labeled to provide quick locating of components. Letters of rows and columns are etched in copper on the boards. Example:



This component is in the fourth row of column A.

The number or letter appearing next to the digital component indicates a pin number on a given integrated circuit. Numbering is conventional.



See figure 22 for the integrated circuit configurations used in the schematic diagrams.

5–5. SYSTEM TROUBLESHOOTING PROCEDURE.

A. Preliminary.

Prior to performing the troubleshooting procedure oulined in Table 5-1, the following checks should be made:

1. Verify that the power cable is properly connected to the battery. The white wire must be connected to the positive terminal and the black wire to the negative terminal.

2. Verify that the five-ampere fuse is not blown.

3. Verify that the male pins in the Odometer Module plug are straight.

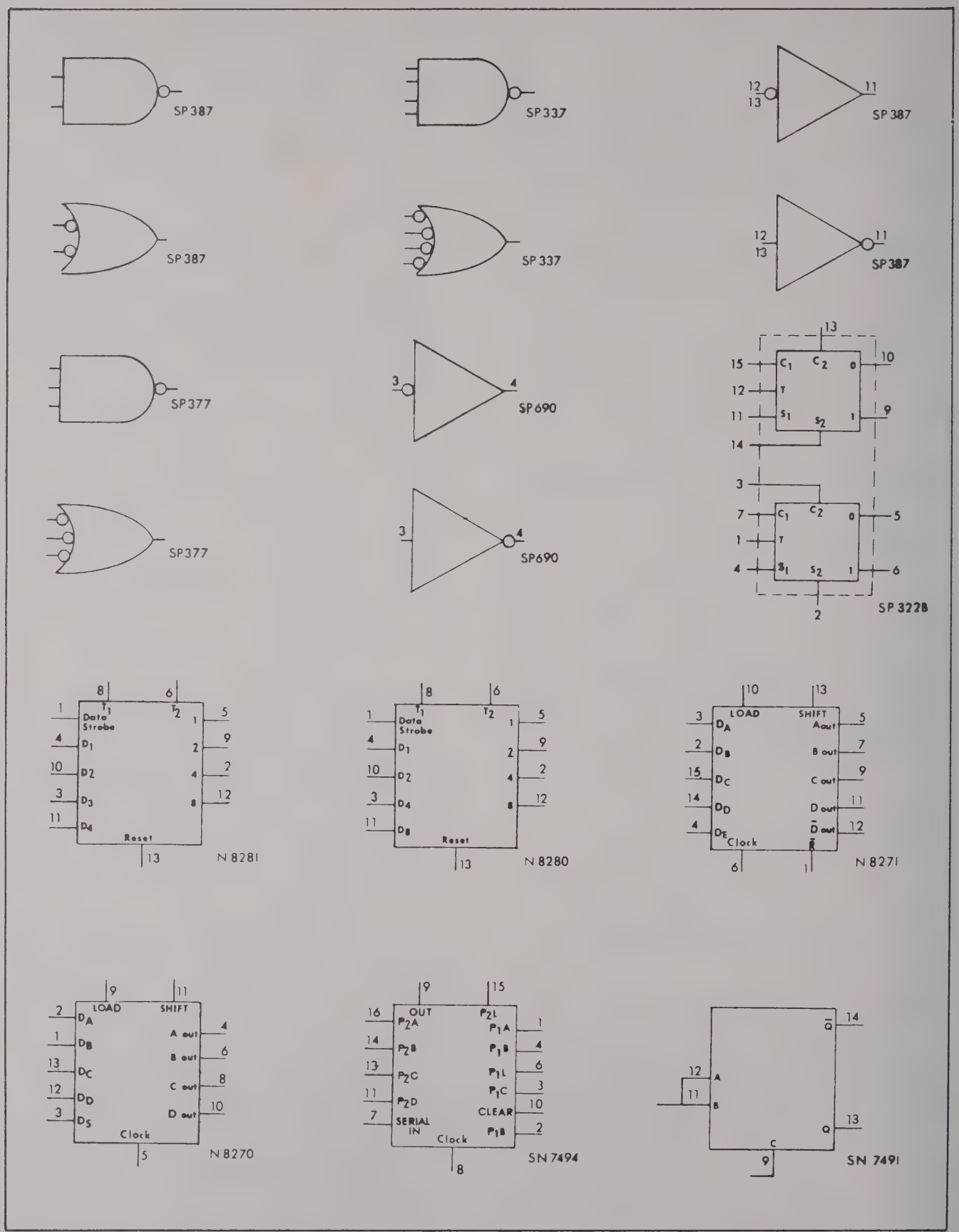
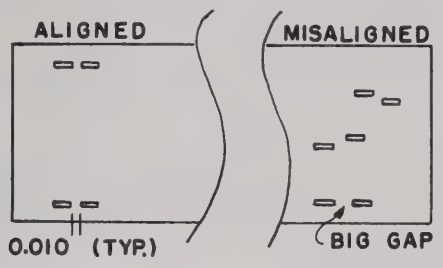


Figure 22. Schematic Symbols.

4. Verify that the individual mating pins and receptacles on the Control Module plug and jack are in proper alignment and position. The jack pins should be orderly as shown below.



If a pin or receptacle is misaligned, and it is necessary to remove a connector for repair, refer to the Control Module disassembly paragraph (paragraph 5-6, B). All connectors in this plug should be within approximately 1/16-inch of the surface of the plug. If one or more of the connectors are more than 1/16-inch below the plug surface,the plug must be partially disassembled and the loose contact pushed-in until it locks in position.

5. When inserting plugs into jacks, ensure they go all the way in.

B. Troubleshooting Procedure.

Perform the procedures under the symptom of malfunction in Table 5-1. After the malfunctioning module has been determined, refer to the specific troubleshooting procedure for that module. If the symptom is not given in Table 5-1, perform the specific troubleshooting procedure for the suspect module.

Table 5-1. System Troubleshooting Procedure.

1. Symptom: No lights on Readout (including decimal point).	
Procedure	Corrective Action
a. Check five ampere fuse.	Replace if defective.
b. Remove power plug from Computer Module. Check for battery voltage (10 to 16.5 VDC) between pins 1 and 2. Note: Pin 1 (large) is negative	If battery voltage is not obtained, repair power cable.
c. Remove Control Module plug from Computer Module. Connect power plug to Computer Module. Check for battery voltage between case ground and Control Module jack pin L (JC-L). Battery voltage should also be present between case ground and JC-PP.	If battery voltage is not obtained, replace Computer Module.
d. Set Control Module Power Switch to ON. Check for continuity on Control Module plug from PC-L to PC-B and from PC-M to PC-PP.	If continuity is not obtained, repair or replace Control Module.
e. With Power switch set to ON, connect a 12V DC source between PC-PP (+) and PC-EE(-). After decimal point lamp illuminates, connect source between PC-L(+) and PC-EE(-). Decimal point lamp should illuminate in both cases.	If decimal point lamp does not illuminate, repair or replace Control Module.
f. Remove power plug. Connect Control Module plug to Computer Module. Remove Odometer Module plug and reconnect power plug. Set Power switch to ON. Connect a voltmeter between case ground and Odometer Module jack pin 4 (JO-4). Voltmeter should indicate 5.0 ± 0.2 VDC.	If voltmeter does not indicate 5.0 ± 0.2VDC, replace Computer Module.

2. Symptom: Decimal point is the only lamp that will illuminate.	
Procedure	Corrective Action
a. Ensure that the temperature inside the Computer Module case is below 175°F.	
b. Set Control Module Power Switch to ON. Check for continuity on Control Module plug from PC-L to PC-B and from PC-M to PC-PP.	If continuity is not obtained in both cases, repair Control Module.
c. Remove power plug. Connect Control Module plug to Computer Module. Remove Odometer Module plug and reconnect power plug. Set Power switch to ON. Connect a voltmeter between case ground and Odometer Module jack pin 4 (JO-4). Voltmeter should indicate 5.0 ± 0.2 VDC.	If voltmeter does not indicate 5.0 ± 0.2 VDC, replace Computer Module.

Table 5-1. System Troubleshooting Procedure (cont.).

3. Symptom: Control Module displays 00.1 all the time.	
Procedure	Corrective Action
a. Set Control Module Power switch to ON. Depress black reset pushbutton. Wait five minutes.	If unit clears to 00.0 after five minutes, the system is not malfunctioning. If unit does not clear to 00.0 proceed to procedure b.
b. Remove power plug. Remove OdometerModule plug. Reconnect power plug. Set Control Module Power switch to ON and depress black reset pushbutton. Wait five minutes.	If unit clears to 00.0, repair or replace Odometer Module. If unit does not clear to 00.0, proceed to procedure c.
c. Remove power plug. Remove Control Module plug. Perform all continuity checks in Control Module Troubleshooting paragraph.	If continuity is not obtained in all checks, repair or replace Control Module. If continuity is obtained and symptom persists, repair or replace Computer Module.

4. Symptom: Flashing numbers. VASCAR will not stop computing after a clock is made (often called rolling 8's).	
Procedure	Corrective Action
Remove power plug. Remove Control Module plug. Perform all continuity checks in Control Module Troubleshooting paragraph.	If continuity is not obtained in all checks, repair or replace Control Module. If continuity is obtained and symptom persists, repair or replace Computer Module.

5. Symptom: VASCAR reads 00.0 under all conditions, unless a 00.1 error condition is introduced.	
Procedure	Corrective Action
a. With the VASCAR system installed for normal operation and the vehicle moving at approximately 30 MPH, proceed as follows: (1) Set Power switch to ON. (2) Depress black reset pushbutton. (3) After readout clears to 00.0, set the TIME and DIST. toggle switches to ON for approximately one second, then OFF.	If readout displays a low speed, typically 00.2 to 05.0, repair or replace Odometer Module.
b. Remove power plug. Remove Control Module plug. Perform all continuity checks in Control Module Troubleshooting paragraph.	If continuity is not obtained in all checks, repair or replace Control Module. If continuity is obtained and symptom persists, repair or replace Computer Module.

Table 5-1. System Troubleshooting Procedure (cont.).

6. Symptom: Unit calibration cannot be changed.	
Procedure	Corrective Action
Remove power plug. Remove Control Module plug. Connect an ohmmeter between terminals E and F on the Control Module plug (PC-E to PC-F). Vary the calibration potentiometer (25 turn) clockwise and then counterclockwise. Observe that the ohmmeter indicates a uniform change, through 25 turns, from 400 to 19,600 ohms.	If correct resistance reading is not obtained, check wiring before assuming faulty potentiometer. Refer to paragraph 5-6 Control Module Troubleshooting Procedure. If correct resistance reading is obtained, repair or replace Computer Module.

7. Symptom: Readout displays abnormally low speeds.	
Procedure	Corrective Action
Remove power plug. Remove Odometer Module plug. Remove Computer Module inspection plate as shown in figure 28. Connect a jumper (0.080 inch probes on each end) from TP3 (orange) to TP8 (gray). Reconnect power plug. Set Power switch to ON. Depress black reset pushbutton. After the readout displays 00.0, set the TIME and DIST. toggle switches ON, then OFF simultaneously. The readout will display approximately •02.4 MPH.	If readout fails to display approximately •02.4 MPH, repair or replace Computer Module. If readout displays approximately •02.4 MPH, repair or replace Odometer Module.

8. Symptom: Readout displays incomplete numbers.	
Procedure	Corrective Action
Remove power plug. Remove Control Module plug. Connect the positive (+) lead of a 12 VDC power supply to pin B of the Control Module plug (PC-B). Touch the negative (-) lead of the supply to each of the lamp lead pins (see figure 30), and observe that the correct lamp illuminates. NOTE: Pins are lettered on plug side of Control Module.	If the correct lamp does not illuminate, repair or replace Control Module. If the correct lamp illuminates, repair or replace Computer Module.

9. Symptom: Readout will clear to 00.0, but goes to 00.1 when either the TIME or DIST. switch is activated.	
Procedure	Corrective Action
Remove power plug. Remove Control Module plug. Perform all continuity checks in Control Module Troubleshooting paragraph.	If continuity is not obtained in all checks, repair or replace Control Module. If continuity is obtained and symptom persists, repair or replace Computer Module.

Table 5-1. System Troubleshooting Procedure (cont.).

10. Symptom: VASCAR system malfunctions intermittently.	
Procedure	Corrective Action
a. Remove power plug. Remove Odometer Module and Control Module plugs. Check individual plug contacts as outlined in paragraph 5-5A, steps 3 and 4.	If not aligned properly, bent, etc., repair as necessary.
b. With power plug removed, remove inspection plate. Loosen and re-seat the time, distance and speed boards in their respective connectors.	Self correcting.
c. If a. and b. fail to correct the intermittent malfunction, perform the suggested procedure for the symptom present during the period of failure.	

11. Symptom: VASCAR cannot be reset by depressing TIME or DIST. pushbutton.	
Procedure	Corrective Action
Remove power plug. Remove Control Module plug. Perform all continuity checks in Control Module Troubleshooting paragraph.	If continuity is not obtained in all checks, repair or replace Control Module. If continuity is obtained and symptom persists, repair or replace Computer Module.

12. Symptom: Readout displays erratic speed readings.	
Procedure	Corrective Action
a. Remove power plug. Remove Odometer Module and Control Module plugs. Check individual plug contacts as outlined in paragraph 5-5A, steps 3 and 4.	If not aligned properly, bent, etc., repair as necessary.
b. Remove power plug. Remove Control Module plug. Perform all continuity checks in Control Module Troubleshooting paragraph.	If continuity is not obtained in all checks, repair or replace Control Module. If continuity is obtained and symptom persists, repair or replace Computer Module.
c. Allow the system to cool for at least 15 minutes. Install a five ampere (or higher) ammeter in the positive leg of the power cord. Set the Power switch to ON and observe the ammeter. The initial current will be 2.9 to 3.4 amperes. After the oven has warmed up the current will level off at 2.1 to 2.4 amperes.	If ammeter does not indicate as described in procedure column, repair or replace Computer Module.

Table 5-1. System Troubleshooting Procedure (cont.).

13. Symptom: System cannot be brought into calibration. Speed calibration can be changed, but not high or low enough.	
Procedure	Corrective Action
a. Verify that no major drive train overhauls have been made on the vehicle. Also, verify that the system had been functioning properly prior to a drive train overhaul.	Contact FEDERAL for special adapter if major overhaul has caused the revolutions of the drive train to be out of tolerance.
b. If the system has been moved to a new vehicle, ensure that the Odometer Module interrupter wheel has the proper number of slots.	Replace Odometer Module with proper type.
c. Remove power plug. Remove Control Module plug. Connect an ohmmeter between terminals E and F on the Control Module plug (PC-E to PC-F). Vary the calibration potentiometer (25 turn) clockwise and then counterclockwise. Observe that the ohmmeter indicates a linear change, through 25 turns, from 400 to 19,600 ohms.	If correct resistance reading is not obtained, check wiring before assuming faulty potentiometer. If correct resistance reading is obtained, repair or replace Computer Module.

14. Symptom: Control Module displays 02.4 all the time, regardless of the amount of time and distance entered into the Computer Module.	
Procedure	Corrective Action
Remove power plug. Remove Control Module plug. Connect an ohmmeter between terminals E and F on the Control Module plug (PC-E to PC-F). Ohmmeter should indicate 0 to 20 K ohms.	If correct resistance reading is not obtained, repair or replace Control Module. If correct resistance reading is obtained, repair or replace Computer Module.

15. Symptom: Speedometer needle jumps. (Probable cause: Something is causing a bind in either the Odometer Module or Odometer cable.)	
Procedure	Corrective Action
a. Disconnect Odometer Module from the speedometer line. It should turn freely and easily. Starting torque should not exceed 3 in. oz.	If Odometer Module binds, it should be repaired or replaced.
b. When re-installing the Odometer Module, ensure that the squared end of the inner flexible cable mates with the squared opening in the Odometer Module shaft. It should enter easily and allow the cable ferrule to come all the way up to the shoulder on the Odometer Module housing before bringing the nut into place.	
c. Look for speedometer cable bends of less than a 6-inch radius.	Re-route cable to avoid sharp bends.
d. If possible, speedometer cable should not apply bending loads to the Odometer Module.	Re-route cable to avoid bending loads.

5–6. CONTROL MODULE TROUBLESHOOTING PROCEDURE.

A. Preliminary.

Prior to performing the troubleshooting procedure outlined in Table 5-2, the following steps should be performed:

1. Remove power plug from Computer Module. Remove Control Module plug from Computer Module.

2. Visually inspect all cables and connectors. Check for cut wires or the presence of foreign material. Also, verify that the individual mating pins and receptacles on the Control Module plug and jack are in proper alignment and position (refer to paragraph 5-5, A, step 4).

B. Disassembly.

If it becomes necessary to disassemble the Control Module, the following steps should be performed. The numbers within parentheses ( ) in the following steps refer to the index numbers in figure 35.

1. Remove six 6-32 x 5/16 pan head screws (#33).

2. Remove cover grille (#18).

3. Remove two 8-32 x $\frac{1}{2}$ RD. HD. screws (#34), and 8-32 hexagon nuts (#35).

4. Carefully remove mounting plate (#13), including components, from housing assembly (#4).

5. The readout connectors (#19) may be removed by grasping them firmly and pulling straight out. A considerable amount of force is required to remove these connectors. In some cases, it will be necessary to pry the connectors off by using a small screwdriver. Care must be taken not to damage the leads or terminals by pulling too far when the maximum tension point is reached and the connector suddenly releases.

6. To replace lamps it will be necessary to remove and disassemble the readout as follows (see figure 23).

a. Remove the readout connectors (refer to step 5, above).

b. Remove the nuts and lockwashers used to secure the readout to the mounting plate. Remove readout from housing.

c. Using a knife or other pointed instrument, carefully pry the backing cover from the readout body.

d. Remove the end caps by wedging a knife between the body and end caps. Gently pry end caps away from body. A silicone rubber sealant is used to hold the end caps to the readout body for easier factory assembly. It should be carefully peeled or picked off.

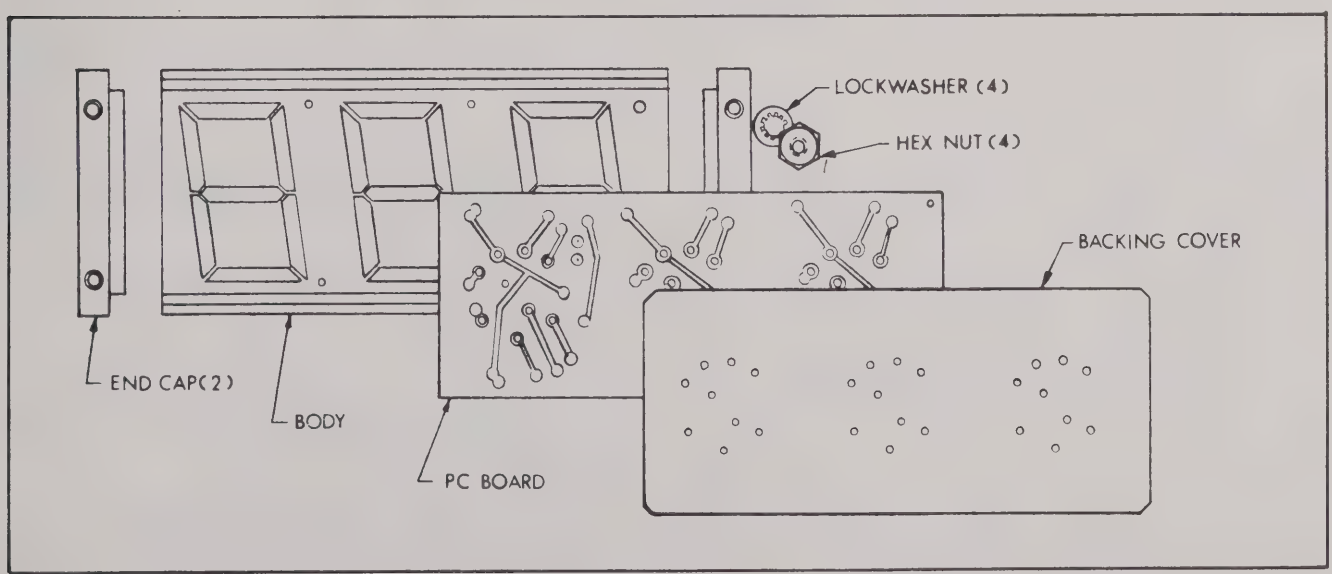


Figure 23. Readout Disassembly.

e. The PC board may be removed by carefully inserting a knife between the PC board and the readout body. Lift the PC board at one end and visually observe the lamps as the board pivots about the other end. In some units, the lamp may fit tightly in the readout body openings and will crack if the PC board is carelessly lifted.

f. When replacing lamps, use a 20-30 watt soldering iron. Avoid applying too much heat.

g. On some units the hundred MPH and decimal point lamps have been connected as shown in figure 24. In this instance, the lamp leads are connected to the foil on the underside of the board through small holes. Note that the large holes on the board are vacant. When this is the case, the following procedure should be performed when installing a new lamp.

(1) Remove the defective lamp.

(2) Insert the new lamp in the large hole on the board.

(3) Connect the lamp leads as shown in figure 25. Place insulation sleeving over the decimal point lead as shown in figure 25.

(4) Replace the resistor associated with the defective lamp with a 330 ohm, 1/8 watt resistor.

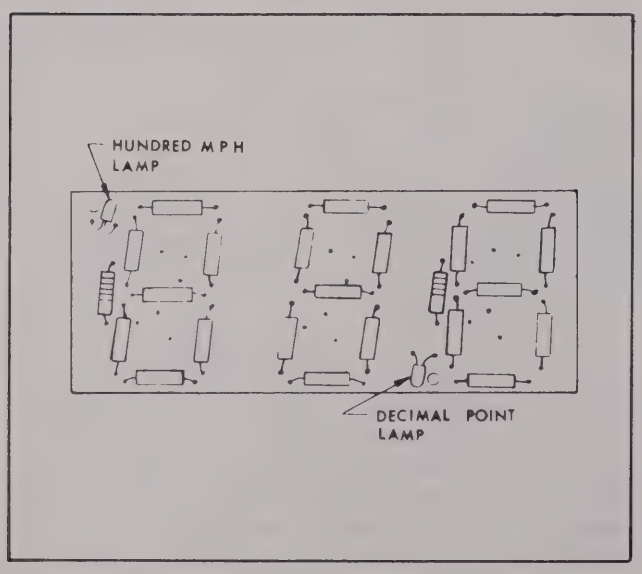


Figure 24. Lamp Location.

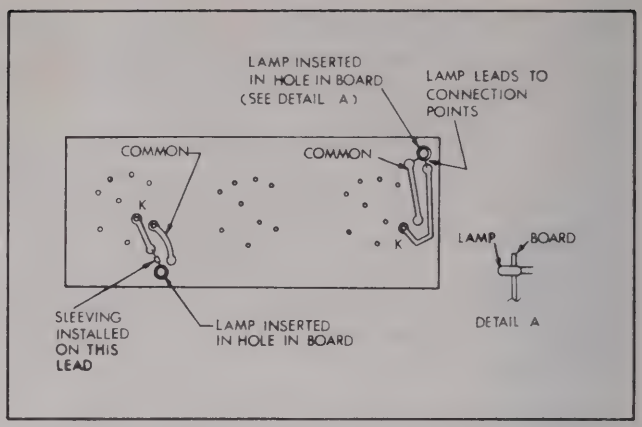


Figure 25. Lamp Installation.

NOTE

On units that have the hundred MPH and decimal point lamps installed as shown in figure 25, it will not be necessary to replace the resistor.

h. To reassemble the readout, perform steps a through g (above) in reverse order.

NOTE

When reassembling the readout, it is not necessary to use the silicone rubber if the module is held together firmly enough to allow the nuts to be tightened. Ensure the terminal strip (#17, figure 35) is firmly mounted.

7. To reassemble the Control Module, perform steps 1 through 6 (above) in reverse order.

8. If the problem is traced to the connector plug, use figure 26 as a guide and proceed as follows:

a. Loosen the two clamp screws.

b. Remove the four cover screws.

c. Remove the cover from the base. Look for normal electrical failures.

d. The individual contacts are held in place by barbs. If they must be removed, use special removal tool (Elco No. T-06-1877-02).

e. When installing contacts, press them in from the rear until the barbs lock in place.

C. Troubleshooting Procedure.

Perform the procedures which follow the symptom of malfuncation in Table 5-2. If the symptom is not given in Table 5-2, refer to the Control Module section of figure 30 and use normal troubleshooting techniques.

In all cases, the wiring and connectors associated with a suspected faulty component should be considered suspect.

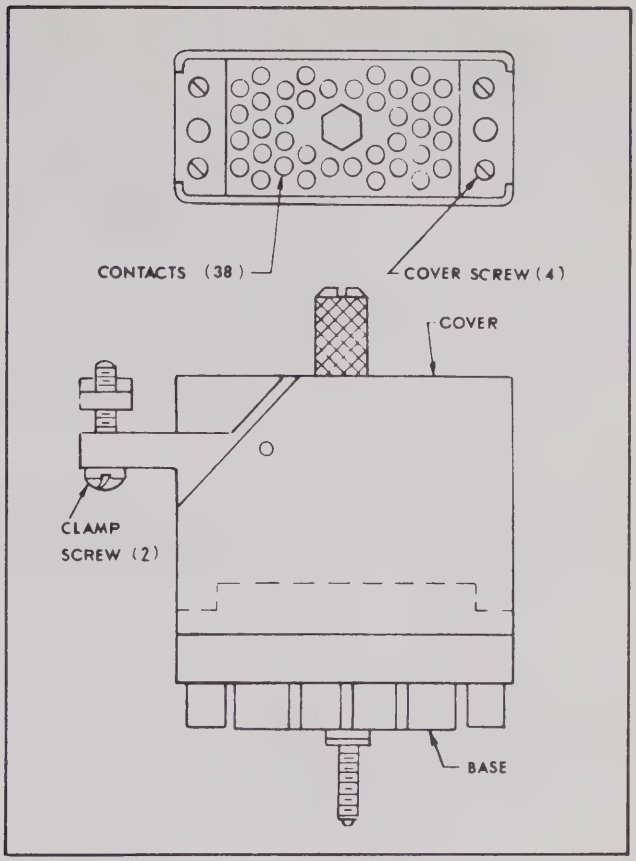


Figure 26. Control Module Plug.

Table 5-2. Control Module Troubleshooting Procedure.

Symptom	Procedure	Corrective Action
1. No lights illuminate.	a. Set Power switch to ON. Check for continuity between connector pins PP and B. b. Visually inspect BRIGHTNESS potentiometer. Connect an ohmmeter from the wiper terminal of the BRIGHTNESS potentiometer to one of the other terminals. Observe that the ohmmeter varies from 0 to 25 ohms, while rotating the potentiometer between its limits.	If continuity is not obtained, replace Power switch. If visual inspection reveals a defect or if proper ohmmeter indication is not obtained, replace BRIGHTNESS potentiometer.
2. Decimal Point is the only lamp that illuminates.	Set Power switch to ON. Check for continuity between connector pins PP and B. Examine the Power switch connections and pins PP and B for a possible broken wire.	If continuity is not obtained, replace Power switch. Repair broken wire if applicable.
3. Unit does not calibrate.	Connect an ohmmeter between connector pins E and F. Observe that the ohmmeter varies from approximately 400 to 19,600 ohms, while rotating the CAL potentiometer between its limits (25 turn potentiometer).	If proper ohmmeter indication is not obtained, replace CAL. potentiometer.
4. Flashing numbers after entering time and distance information.	Connect an ohmmeter between connector pins E and F. Set CAL. potentiometer to its approximate mid-point. Ohmmeter should indicate approximately 10K ohms.	If proper ohmmeter indication is not obtained, replace CAL. potentiometer.
5. Time reset function is inoperative.	Connect an ohmmeter between connector pins S and EE. Ohmmeter should indicate continuity when TIME reset pushbutton is depressed.	If continuity is not obtained, replace TIME reset pushbutton.
6. Distance reset function is inoperative. (00.1 cannot be cleared.)	Connect an ohmmeter between connector pins Z and EE. Ohmmeter should indicate continuity, when DIST. reset pushbutton is depressed.	If continuity is not obtained, replace DIST. reset pushbutton.
7. Unit indicates 00.0 all the time.	a. Set TIME toggle switch to ON. Connect an ohmmeter between connector pins EE and JJ. Ohmmeter should indicate continuity b. Set TIME toggle switch to OFF. Connect an ohmmeter between connector pins EE and DD. Ohmmeter should indicate continuity.	If continuity is not obtained, replace TIME toggle switch If continuity is not obtained, replace TIME toggle switch.

Table 5-2. Control Module Troubleshooting Procedure, (cont.).

Symptom	Procedure	Corrective Action
7. (Continued)	c. Set DIST. toggle switch to ON. Connect an ohmmeter between connector pins EE and X. Ohmmeter should indicate continuity.	If continuity is not obtained, replace DIST. toggle switch
	d. Set DIST. toggle switch to OFF. Connect an ohmmeter between connector pins EE and V. Ohmmeter should indicate continuity.	If continuity is not obtained, replace DIST. toggle switch.
8. Unit indicates 00.1 when TIME or DIST. toggle switches are actuated. (Unit can be cleared to 00.0 with DIST. (system) reset pushbutton.)	a. Set TIME toggle switch to ON. Check for continuity between connector pins EE and JJ, and open circuit between pins EE and DD. NOTE: Switch should be checked to ensure that a double "make" or "break" condition is not present.	If correct indication is not obtained, replace TIME toggle switch.
	b. Set DIST. toggle switch to ON. Check for continuity between connector pins EE and X, and open circuit between pins EE and V. NOTE: Switch should be checked to ensure that a double "make" or "break" condition is not present.	If correct indication is not obtained, replace DIST. toggle switch.
9. Incomplete numbers are displayed.	a. Check for broken wire at non-illuminated lamp pin or corresponding pin on connector.	If wires are not broken, replace applicable lamp.
	b. Ensure that connector is properly seated in Computer Module mating receptacle.	If connector is not properly seated, reseat and tighten knurled connector screw.
10. Unit displays 02.4 all the time, regardless of the amount of time and distance entered into the Computer Module.	Connect an ohmmeter between connector pins E and F. Ohmmeter should indicate between 0 to 20K ohms.	If correct indication is not obtained, replace calibration potentiometer.

5–7. ODOMETER MODULE TROUBLESHOOTING PROCEDURE.

A. Preliminary.

The Odometer Module is designed to withstand the environment normally found at the undercarriage of an automobile. However, its useful life can be greatly extended by placing it in a protected environment. In addition to longer component life, an Odometer Module installed inside the passenger compartment provides easier installation and servicing. All major automobile manufacturers provide two piece speedometer cables for the taxi cab industry. They are typically called taxi packages. This type of cable can be purchased as original equipment, or purchased from automotive service centers as replacement parts.

CAUTION

Each automobile manufacturer has his own unique way of manufacturing this type of cabling. Therefore, it is important to order two-piece cables that will allow complete use of the normal speedometer, whether the Odometer Module is installed or not.

Although there are several types of Odometer Modules, they are basically all the same, and all the electrical circuitry and components are identical.

Prior to performing the troubleshooting procedure, the following steps should be performed:

1. Remove power plug from Computer Module. Remove Odometer Module plug from Computer Module.

2. Verify that the male pins in the Odometer Module plug are straight.

B. Troubleshooting Procedure.

The troubleshooting procedure for the Odometer Module consists of disassembly, mechanical checks and electrical checks. The numbers within parentheses ( ) in the following steps refer to the index numbers in figure 39 (typical).

1. Remove the four 6-32 x 5/16 FIL. HD. screws (#14) and lock washers that secure the cover plate (#2) to the housing (#1).

2. Carefully lift up on the cover plate (#2). The mounting board (#4) and associated hardware will lift free of housing (#1).

3. Examine inside the housing for foreign material, such as oil, water, rust, etc. Clean if necessary.

4. Examine the mounting board and components. Clean if necessary.

5. If the problem is mechanical in nature, the bearing and shaft assembly (#24) may be serviced or replaced by performing the following steps.

a. Remove the silicone sealant covering the retaining ring (#19). New sealant material must be applied before returning the Odometer Module to service.

b. Remove the retaining ring using a standard retaining ring tool.

c. Slide the shaft assembly (#24) out of the housing.

6. If the problem is electrical in nature, use figure 27 as a guide and proceed as follows:

a. Check for continuity as follows:

From pin 1 to terminal B
From pin 3 to terminal R
From pin 4 to terminal W
Repair as necessary.

b. Check for open circuit from pin 2 to pins 1, 3 and 4. Repair as necessary/

c. Apply 5.0 VDC between terminals W and B. The lamp should light. Replace if defective.

d. With the lamp lighted, place a small piece of paper in front of the photo diode. The lamp should project a concentrated beam of light 1/16-inch to 1/8-inch in diameter, which should project toward the photo diode. Replace or align the lamp if the beam characteristics are not correct.

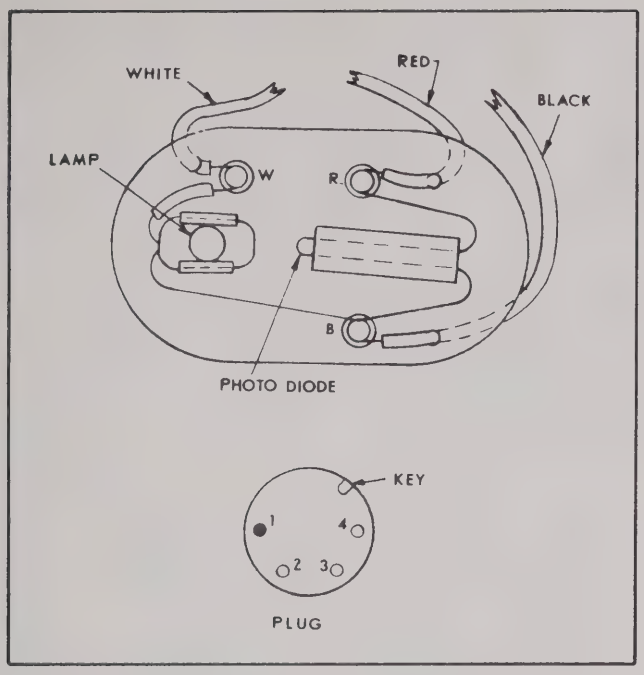


Figure 27. Odometer Module Component Board.

NOTE

If an oscilloscope is used in the following steps, it should be calibrated before making the voltage check. If an oscilloscope is not used, a high-impedance voltmeter such as a VTVM or Simpson 270 should be used.

e. Remove the 5.0 VDC from terminals W and B.

f. Connect an oscilloscope or high-impedance voltmeter between terminals R and B.

g. Connect the Odometer Module plug into the Odometer Module jack on the Computer Module. Connect the power plug and Control Module plugs into their respective Computer Module receptacles. Set the Control Module Power switch to ON.

h. Place the mounting board and components in subdued lighting. Use an opaque insulating material to interrupt the beam of light going to the diode. When the light is striking the photo diode, the oscilloscope or voltmeter should indicate less than $1-\frac{1}{2}$ volts. When the light is not striking the diode, the voltage should be greater than 4.0 volts. If these limits are not exceeded, replace the diode.

7. When reassembling the Odometer Module, check all silicone rubber seals to ensure that they will prevent water and oil entry. Add additional silicone sealant if necessary. The gasket (#13) provides a primary seal, and the surfaces it seals should be clean and smooth. If the gasket is deformed, it should be replaced.

8. When the mounting board (#4) is properly nestled in the housing opening prior to tightening screws, the cover plate (#2) will come down flush with the gasket.

9. The screws (#14) and lockwashers should be tightened securely before returning the Odometer Module to service.

10. When installing the Odometer Module into the speedometer line, careful attention should be given to the proper alignment of the squared tip of the inner flexible cable and the square opening in the Odometer Module shaft. When properly installed, the ferrule on the cable will "butt" against the mating surface on the Odometer Module without using the cable nut to force it into place. When the nut is subsequently tightened securely by hand, it will retain the ferrule in its proper location. In all cases, the applicable paragraph in Section IV of this manual should be used when installing the Odometer Module in a vehicle.

5–8. COMPUTER MODULE TROUBLESHOOTING PROCEDURE.

The advanced features of VASCAR II allow a qualified technician to easily isolate a malfunction in the Computer Module to a faulty component board. By merely taking measurements at the convenient test points, located on the component boards, or by making a few observations on the readout section of the Control Module, a faulty component board can be isolated. Before troubleshooting the Computer Module, the operator and/or technician should determine that the fault is in the Computer Module and not in the Odometer or Control Modules.

A. Preliminary.

Troubleshooting the VASCAR II Computer Module can be accomplished in either the vehicle or in a repair area. Troubleshooting the Computer Module in the vehicle can

eliminate disassembly time and the time needed to connect the unit in the repair area. Prior to performing the Computer Module Troubleshooting Procedure, the following steps should be performed.

1. Fabricate a few jumper wires with 0.080 diameter test plugs on each end. Each jumper wire should be approximately six inches long.

2. Examine all Computer Module case connectors for bent or damaged pins.

3. If a power cable is not available, it may be fabricated as follows:

a. Obtain a Cinch Jones S302-CCT-C plug.

b. Connect a length of black 16 gauge wire to the plug terminal that is connected to the large prong.

c. Connect a length of white 16 gauge wire to the plug terminal that is connected to the small prong.

CAUTION

When connecting this cable to a power source, the small prong on the plug (white wire) must be connected to the positive (+) side of the power source. Reversing the connections will cause the fuse to blow.

B. Disassembly.

If it becomes necessary to disassemble the Computer Module, the following steps should be performed. The numbers within parentheses ( ) in the following steps refer to the index numbers in figure 42.

1. Set the Control Module Power switch to OFF. Remove the power plug, Control Module plug and Odometer Module plug.

2. Remove the inspection plate (#3) by removing the two pan head screws (#20) securing the inspection plate to the Computer Module case. Carefully insert a screwdriver into the slot on the inspection plate and pivot out (see figure 28).

3. To remove the component boards proceed as follows:

a. Remove four bottom cover screws (#25). Lay the Computer Module upside-down on a clean work surface and lift the bottom cover (#2) straight up.

b. The speed (#13), time (#14) and distance (#15) component boards can be removed by placing the thumbs of both hands at the bottom of the board, near the connector, and gently pushing out.

CAUTION

The component boards have a tendency to spring suddenly out of the connector and beyond the card guides, when pressure is applied. To avoid damage to the component board, ensure that the board does not spring completely out of the Computer Module case.

c. The analog component board (#16) can be removed by removing the two mounting screws (#22) that secure the board to the Computer Module case. Gently push the board out, away from its connector.

NOTE

Replacing transistors (#5) or (#12), or any component on the printed circuit boards, will void the warranty. If components are defective in warranty, return the complete Computer Module or individual component boards.

4. If it is necessary to replace either power transistor (#5) or (#12), when the unit is out of warranty, care must be taken to properly insulate the transistor and leads, electrically, without causing any thermal insulation. A high efficiency heat sink compound, similar to Dow-Corning #340, should be used.

C. Troubleshooting Procedure.

After it has been determined that the fault is in the Computer Module, remove the inspection plate (refer to paragraph 5-8,

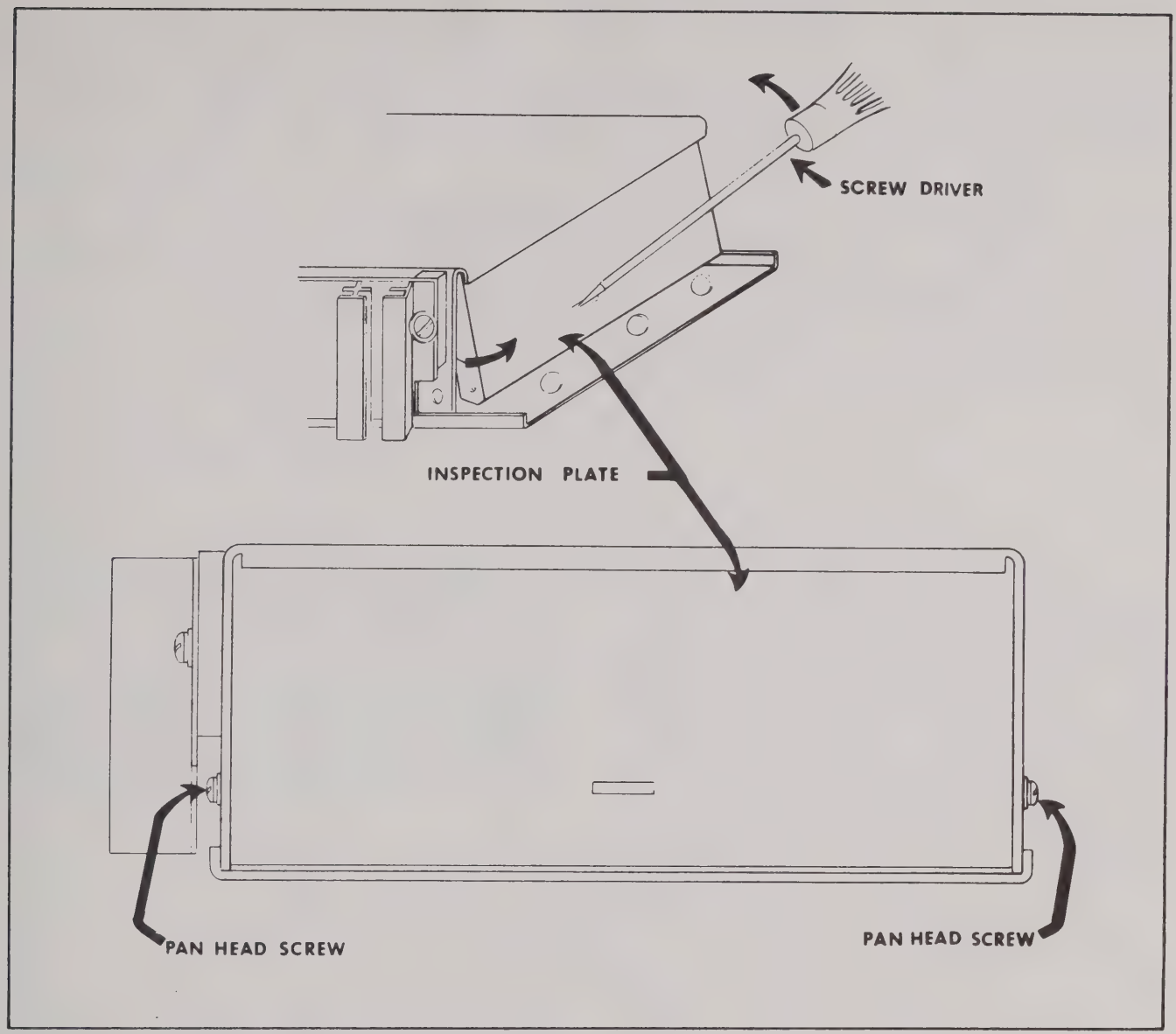


Figure 28. Inspection Plate Removal.

B, step 2). Connect a Control Module to the Computer Module. Connect a power cable to the power receptacle on the Computer Module.

The only troubleshooting method which will yield 100% results is to have a trained digital engineer check a defective Computer Module with the aid of the schematic diagrams (see figures 30, 31, 32, 33 and 34). The troubleshooting procedure, Table 5-3, will determine a faulty component board to an estimated 85% confidence level and is included for quick reference. Figure 29 shows the location and color of test points. Refer to this figure when connecting jumper wires or making measurements as outlined in Table 5-3.

All operations in the PROCEDURE column of Table 5-3 should be performed in the sequence shown for the symptom of malfunction. All controls and indicators mentioned are located on the Control Module. If the normal indication shown in the PROCEDURE column is not obtained, replace the component listed in the CORRECTIVE ACTION column. Prior to replacing component boards, refer to paragraph 5-8, B, step 3. All procedural steps under a malfunction should be performed prior to returning a Computer Module to service. It is assumed that all wiring and connections are in good repair. However, it is recommended that all wiring be checked prior to performing the troubleshooting procedure.

TEST POINT	COLOR
1	BROWN
2	RED
3	ORANGE
4	YELLOW
5	GREEN
6	BLUE
7	VIOLET
8	GRAY
9	WHITE

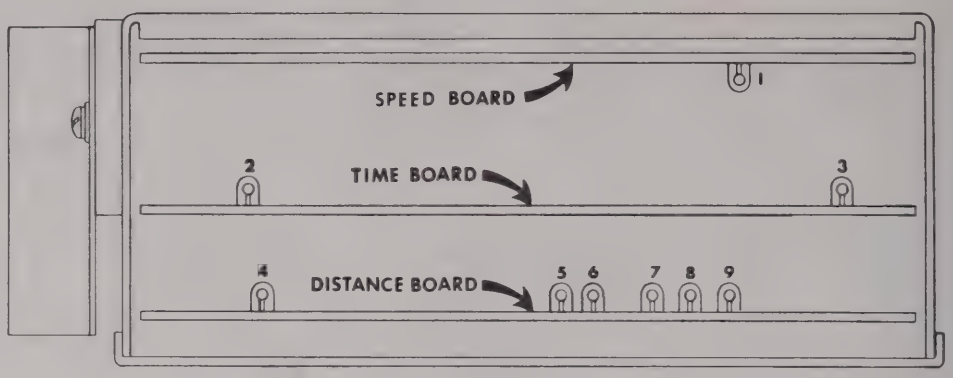


Figure 29. Test Point Location.

When performing the checks in Table 5-3, the Computer Module must be connected to a known good Control Module and a well-filtered 12 VDC power supply (preferably, an automotive battery). Power must be removed from the Computer Module prior to removing or replacing component boards or modules. Prior to performing the checks in the PROCEDURE column, the Power switch should be set to ON and the unit allowed to warm-up for approximately five minutes.

If the normal indication is not obtained, the technician can be relatively certain that the component shown in the CORRECTIVE ACTION column is at fault. When all correct indications in the applicable PROCEDURE column are obtained, the technician should use other troubleshooting techniques (replacement, continuity checks, etc.) to isolate the malfunctioning component.

Table 5-3. Computer Module Troubleshooting Procedure.

1. Symptom: No lights on Control Module	
Procedure	Corrective Action
Check five ampere fuse.	Replace fuse.

2. Symptom: Decimal point is the only lamp that illuminates.	
Procedure	Corrective Action
Check Vcc in Computer Module. (Can be measured at pin V on the Analog board and is marked Vcc.) Connect positive (+) voltmeter lead to Vcc and negative (-) lead to computer case. Voltmeter should indicate approximately 5 VDC.	Replace Computer Module case. See Note 1.

3. Symptom: Control Module continuously displays 00.1 -- even after warm-up.	
Procedure	Corrective Action
Monitor the Computer Module current drain by connecting a DC ammeter in series with white wire of the power cable. At turn-on, ammeter should indicate approximately 3.4 amperes, after warm-up current should drop to approximately 2.4 amperes.	Replace Analog board. See Note 2.

4. Symptom: Control Module displays 00.0 immediately after Power Switch is set to ON.	
Procedure	Corrective Action
Monitor the Computer Module current drain at turn-on by connecting a DC ammeter in series with white wire of power cable. At turn-on, ammeter should indicate approximately 3.4 amperes.	Replace Analog board.

5. Symptom: Control Module displays low or erratic readings.	
Procedure	Corrective Action
With the Power Switch set to OFF, remove the inspection plate (see figure 28). Connect a jumper from TP3 (orange) to TP8 (gray). Remove Odometer Module connector (see Note 3).	
Set Power Switch to ON. Ensure that all other switches are OFF. Press and release the black reset pushbutton. Readout will display error signal (00.1) while oscillator oven heats to operating temperature. (No more than five minutes,	This malfunction is most frequently caused by the Analog board. However, some types of Time and Distance board failures cause the same test results. Therefore, if it is not possible to confirm a faulty

Table 5-3. Computer Module Troubleshooting Procedure (cont.).

5. Symptom (cont.):	
Procedure	Corrective Action
even if cold). After display clears to 00.0, set both TIME and DIST. toggle switches to ON simultaneously. After approximately ten seconds, set both switches OFF simultaneously. Readout will display approximately •02.4.	Analog board by substitution, perform the procedure shown for symptom 6.

6. Symptom: Readout displays 00.0 with time and distance information entered.	
Procedure	Corrective Action
NOTE The normal indication in steps a. and b. are time checks. Observe the position of the second hand of a clock or watch (if available, a stopwatch should be used) prior to setting the TIME or DIST. switches in these steps.	
a. Connect a jumper from TP3 (orange) to TP8 (gray). Remove Odometer Module connector (see Note 3). Set Power Switch to ON. Ensure that all other switches are OFF. Press and release the black reset pushbutton. Set TIME switch to ON. Readout will display error signal (00.1) after six minutes and 24 seconds $\pm$ 40 seconds (5 minutes and 44 seconds to 7 minutes and 4 seconds). Record time it takes for readout to display error signal. Set TIME switch to OFF. Press and release black reset pushbutton. Set TIME switch to ON. Time to display error signal will be identical to previous result.	Replace Time board.
b. Set TIME toggle switch to OFF. Press and release black reset pushbutton. Set DIST. switch to ON. Readout will display error signal (00.1) after 3 minutes and 12 seconds $\pm$ 20 seconds (2 minutes and 52 seconds to 3 minutes and 32 seconds). Record time it takes for readout to display error signal. Set DIST. switch to OFF. Press and release black reset pushbutton. Set DIST. switch to ON. Time to display error signal will be identical to previous result.	Replace Distance board.

Table 5-3. Computer Module Troubleshooting Procedure (cont.).

6. Symptom (cont.):	
c. Set Power Switch to OFF. Remove jumper wire from TP3 and TP8. Connect the positive lead (+) of a DC voltmeter (10 VDC range) to TP2 (red) and the negative lead (-) to TP9 (white). Set Power Switch to ON. Press and release black reset pushbutton. After 00.0 is displayed, press and release black reset pushbutton. DC voltmeter indicates 5 (± 1.0) VDC.	Replace Time board.
d. Press and hold black reset pushbutton. DC voltmeter indicates 2.5 to 3.5 VDC.	Replace Time board.
e. Set Power Switch to OFF. Ensure that all other switches are OFF. Connect the positive lead (+) of a DC voltmeter (10 VDC range) to TP6 (blue) and the negative lead (-) to TP9 (white). Set Power Switch to ON. After readout displays 00.0, press and release black reset button. DC voltmeter indicates approximately 0.0 VDC. NOTE In some units this reading may be as high as 0.5 VDC.	Replace Distance board.
f. Set Power Switch to OFF. Leave DC voltmeter connected from TP6 (blue) to TP9 (white). Connect jumper wire from TP5 (green) to TP9 (white). Set Power Switch to OFF. Press and release black reset pushbutton. After readout displays 00.0, set TIME and DIST. switches to ON for approximately 10 seconds then set them OFF. DC voltmeter indicates 0.0 VDC. Disregard any display on the readout.	Replace Distance board.
g. Set Power Switch to OFF. Leave DC voltmeter connected from TP6 (blue) to TP9 (white). Remove jumper wire installed in step f. Connect jumper wire from TP7 (violet) to TP9 (white). Set Power Switch to ON. Press and release black reset pushbutton. After readout displays 00.0, set TIME and DIST. switches to ON for approximately 10 seconds then set them OFF. DC voltmeter indicates 5(± 1.0) VDC.	Replace Distance board.

Table 5-3. Computer Module Troubleshooting Procedure (cont.).

7. Symptom: Readout displays incomplete or partial numbers.	
Procedure	Corrective Action
a. Remove Odometer Module connector (see Note 3). Set Power Switch to OFF. Remove all previously installed jumper wires. Disconnect DC voltmeter. Connect a jumper wire from TP1 (brown) to TP4 (yellow). Connect a jumper wire from TP8 (gray) to TP3 (orange). Set Power Switch to ON. Press and release black reset push-button. After readout displays 00.0, set TIME switch ON then OFF. Set DIST. switch ON. Readout will count in sequence i.e., first 00.1, then 00.2, then 00.3, etc. Check that the count is in sequence from 00.1 to 10.0. Note speed of count.	Replace Speed board.
b. Set Power Switch and DIST. switch to OFF. Remove all previously installed jumper wires. Connect jumper wire from TP3(orange) to TP1 (brown). Set Power Switch to ON. Press and release black reset pushbutton. After readout displays 00.0, set TIME switch ON then OFF. Check that the 10's digit (extreme left digit) counts in sequence. Readout will count in sequence faster than in previous step.	Replace Speed board.

8. Symptom: Readout will display correct readings when Computer Module is bench checked, but will not operate in vehicle.	
Procedure	Corrective Action
With Computer Module connected for bench test, use an operational Odometer Module for distance input. Drive the Odometer Module at a constant speed. An 1800 RPM synchronous motor is recommended. 1800 RPM is equivalent to 108.0 MPH. Perform steps 7.a. and 7.b. Do not connect any jumpers for this test.	Replace Computer Module case.

NOTES:

1. An estimated 3% of the time, Analog board malfunctions will cause the same test results as a faulty Computer Module case.
2. In some instances, Computer Module case malfunctions will cause the same test results as a faulty Analog board.
3. To remove the Odometer Module connector, proceed as follows:
   a. Push the connector all the way in.
   b. Press and hold the release lever.
   c. Pull the connector out.

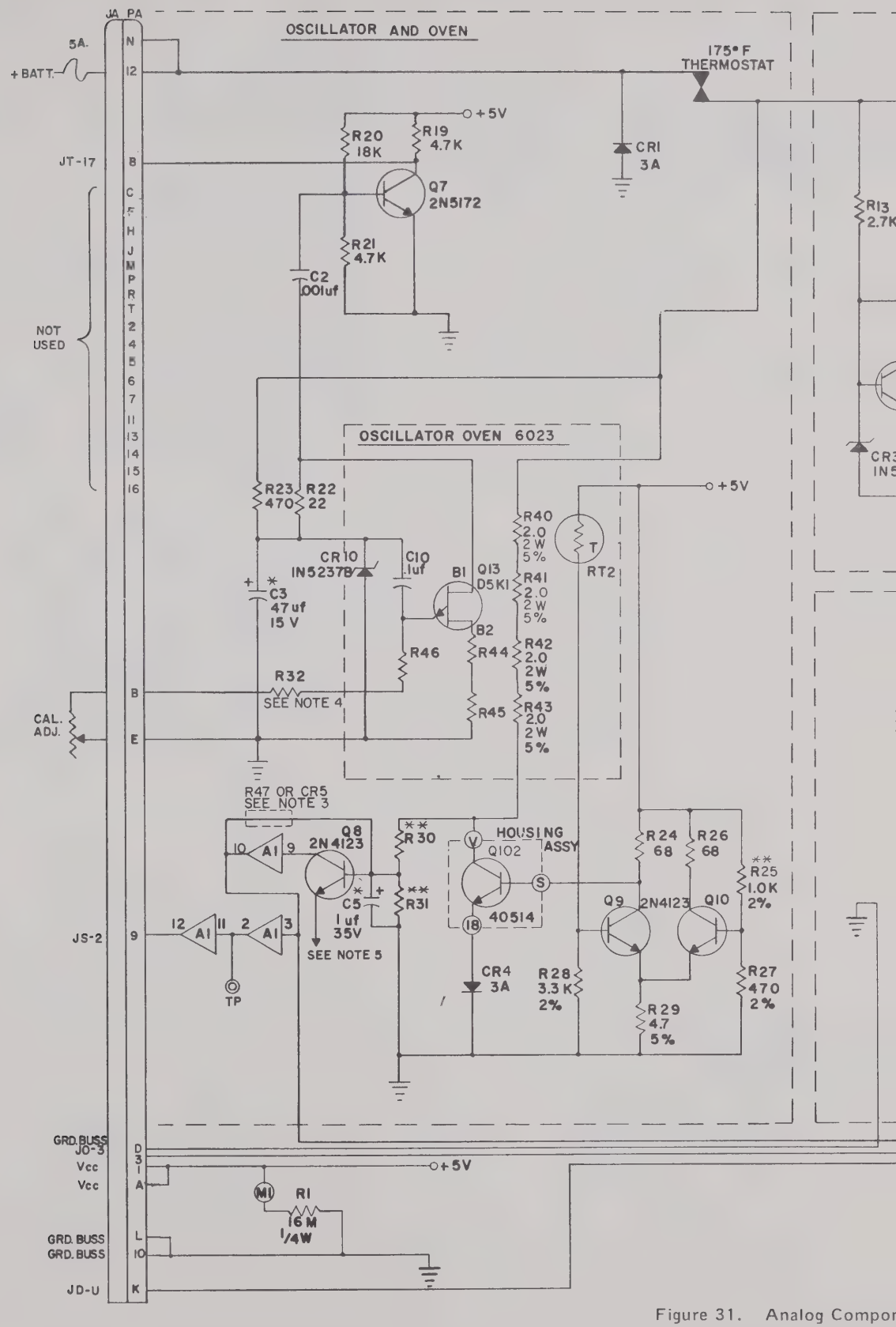


Figure 31. Analog Compon

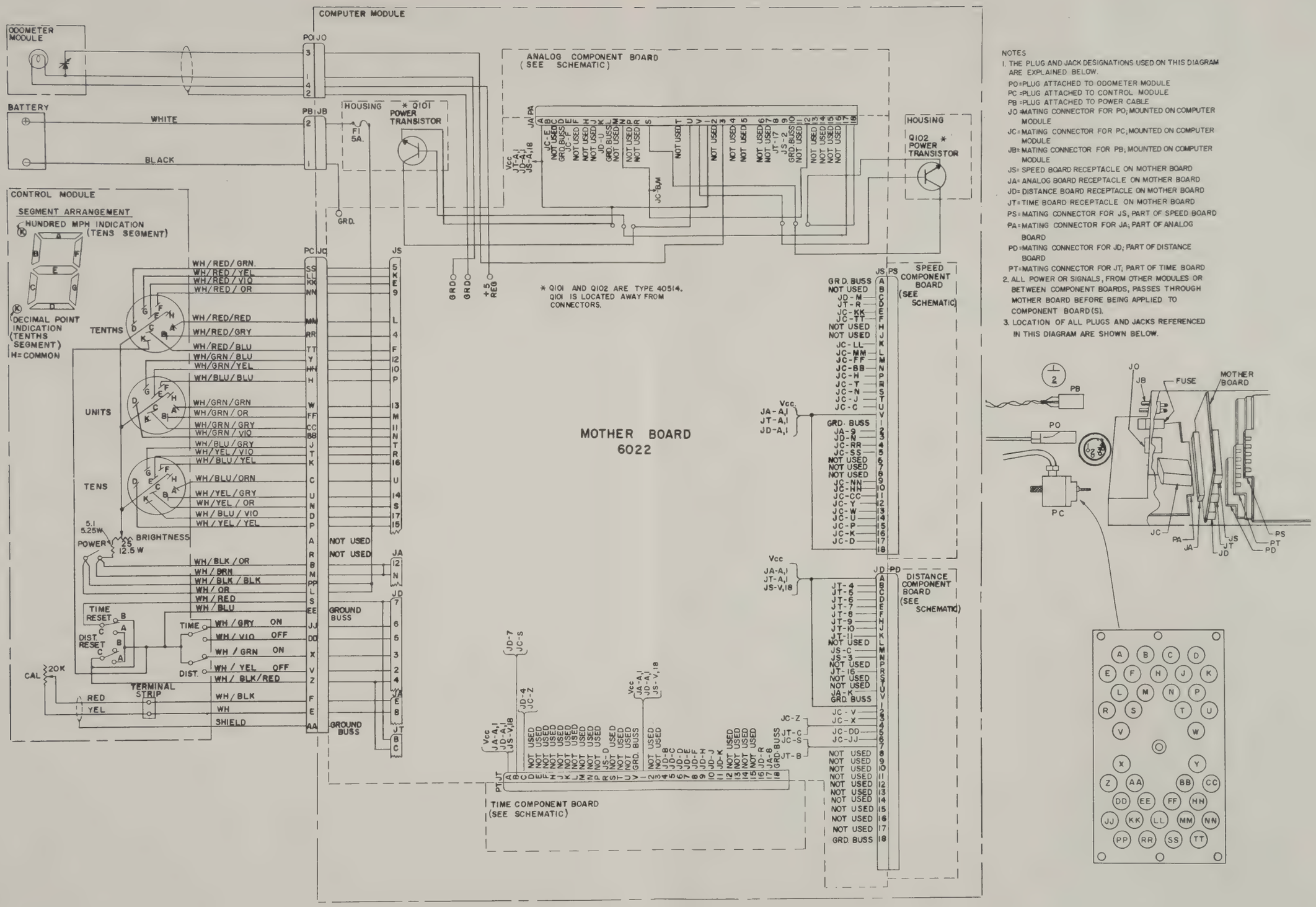
Table 5-3. Computer Module Troubleshooting Procedure (cont.).

7. Symptom: Readout displays incomplete or partial numbers.	
Procedure	Corrective Action
a. Remove Odometer Module connector (see Note 3). Set Power Switch to OFF. Remove all previously installed jumper wires. Disconnect DC voltmeter. Connect a jumper wire from TP1 (brown) to TP4 (yellow). Connect a jumper wire from TP8 (gray) to TP3 (orange). Set Power Switch to ON. Press and release black reset push-button. After readout displays 00.0, set TIME switch ON then OFF. Set DIST. switch ON. Readout will count in sequence i.e., first 00.1, then 00.2, then 00.3, etc. Check that the count is in sequence from 00.1 to 10.0. Note speed of count.	Replace Speed board.
b. Set Power Switch and DIST. switch to OFF. Remove all previously installed jumper wires. Connect jumper wire from TP3(orange) to TP1 (brown). Set Power Switch to ON. Press and release black reset pushbutton. After readout displays 00.0, set TIME switch ON then OFF. Check that the 10's digit (extreme left digit) counts in sequence. Readout will count in sequence faster than in previous step.	Replace Speed board.

8. Symptom: Readout will display correct readings when Computer Module is bench checked, but will not operate in vehicle.	
Procedure	Corrective Action
With Computer Module connected for bench test, use an operational Odometer Module for distance input. Drive the Odometer Module at a constant speed. An 1800 RPM synchronous motor is recommended. 1800 RPM is equivalent to 108.0 MPH. Perform steps 7.a. and 7.b. Do not connect any jumpers for this test.	Replace Computer Module case.

NOTES:

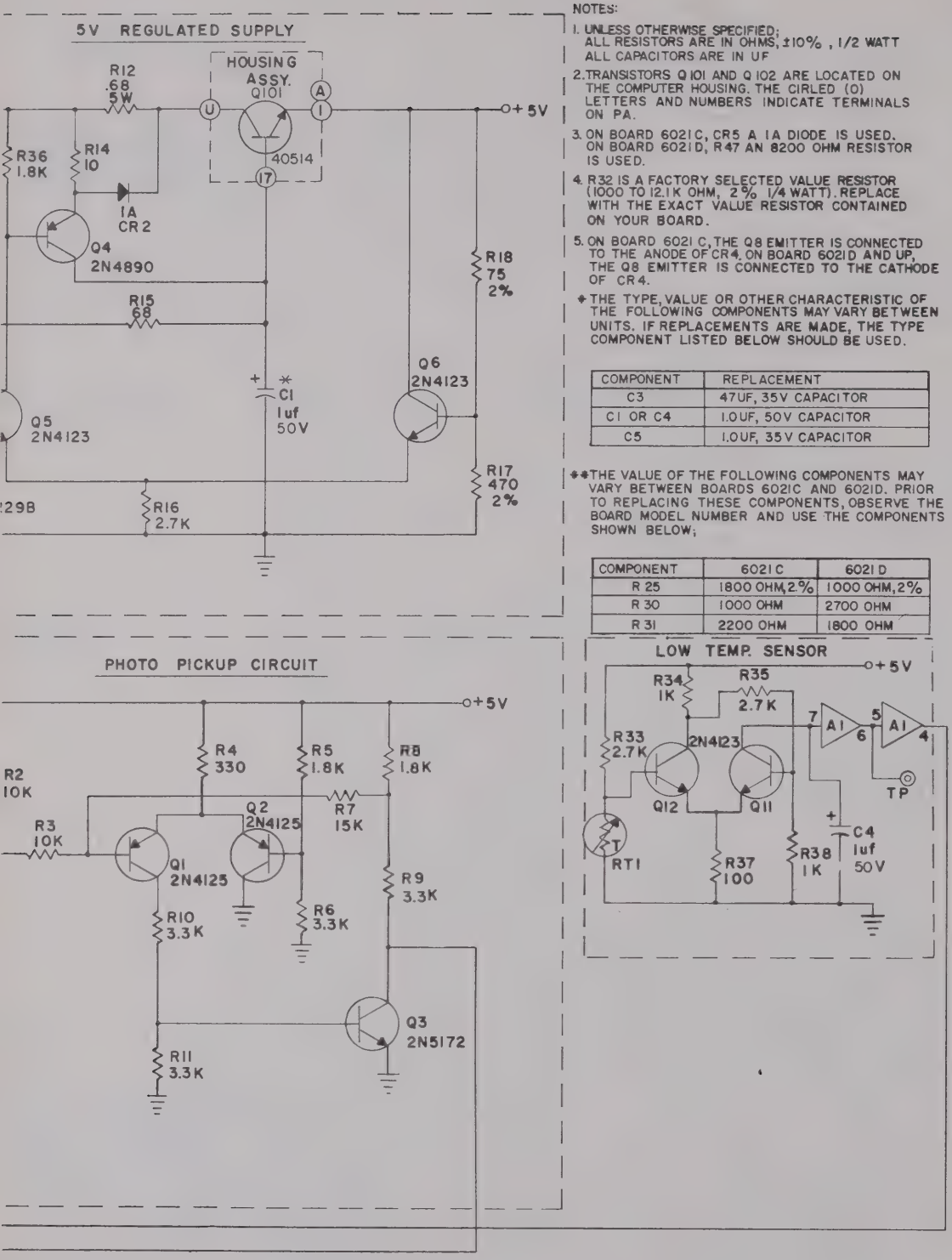
1. An estimated 3% of the time, Analog board malfunctions will cause the same test results as a faulty Computer Module case.
2. In some instances, Computer Module case malfunctions will cause the same test results as a faulty Analog board.
3. To remove the Odometer Module connector, proceed as follows:
   a. Push the connector all the way in.
   b. Press and hold the release lever.
   c. Pull the connector out.



NOTES

1. THE PLUG AND JACK DESIGNATIONS USED ON THIS DIAGRAM ARE EXPLAINED BELOW.
   - PO = PLUG ATTACHED TO ODOMETER MODULE
   - PC = PLUG ATTACHED TO CONTROL MODULE
   - PB = PLUG ATTACHED TO POWER CABLE
   - JO = MATING CONNECTOR FOR PO; MOUNTED ON COMPUTER MODULE
   - JC = MATING CONNECTOR FOR PC; MOUNTED ON COMPUTER MODULE
   - JB = MATING CONNECTOR FOR PB; MOUNTED ON COMPUTER MODULE
   - JS = SPEED BOARD RECEPTACLE ON MOTHER BOARD
   - JA = ANALOG BOARD RECEPTACLE ON MOTHER BOARD
   - JD = DISTANCE BOARD RECEPTACLE ON MOTHER BOARD
   - JT = TIME BOARD RECEPTACLE ON MOTHER BOARD
   - PS = MATING CONNECTOR FOR JS, PART OF SPEED BOARD
   - PA = MATING CONNECTOR FOR JA; PART OF ANALOG BOARD
   - PD = MATING CONNECTOR FOR JD; PART OF DISTANCE BOARD
   - PT = MATING CONNECTOR FOR JT; PART OF TIME BOARD
2. ALL POWER OR SIGNALS, FROM OTHER MODULES OR BETWEEN COMPONENT BOARDS, PASSES THROUGH MOTHER BOARD BEFORE BEING APPLIED TO COMPONENT BOARD(S).
3. LOCATION OF ALL PLUGS AND JACKS REFERENCED IN THIS DIAGRAM ARE SHOWN BELOW.

Figure 30. System Schematic and Interconnecting Wiring Diagram.



NOTES:

1. UNLESS OTHERWISE SPECIFIED: ALL RESISTORS ARE IN OHMS, ±10% , 1/2 WATT ALL CAPACITORS ARE IN UF
2. TRANSISTORS Q 101 AND Q 102 ARE LOCATED ON THE COMPUTER HOUSING. THE CIRLED (O) LETTERS AND NUMBERS INDICATE TERMINALS ON PA.
3. ON BOARD 6021C, CR5 A 1A DIODE IS USED. ON BOARD 6021D, R47 AN 8200 OHM RESISTOR IS USED.
4. R32 IS A FACTORY SELECTED VALUE RESISTOR (1000 TO 12.1K OHM, 2% 1/4 WATT). REPLACE WITH THE EXACT VALUE RESISTOR CONTAINED ON YOUR BOARD.
5. ON BOARD 6021 C, THE Q8 EMITTER IS CONNECTED TO THE ANODE OF CR4. ON BOARD 6021D AND UP, THE Q8 EMITTER IS CONNECTED TO THE CATHODE OF CR4.

* THE TYPE, VALUE OR OTHER CHARACTERISTIC OF THE FOLLOWING COMPONENTS MAY VARY BETWEEN UNITS. IF REPLACEMENTS ARE MADE, THE TYPE COMPONENT LISTED BELOW SHOULD BE USED.

COMPONENT	REPLACEMENT
C3	47UF, 35V CAPACITOR
C1 OR C4	1.0UF, 50V CAPACITOR
C5	1.0UF, 35V CAPACITOR

** THE VALUE OF THE FOLLOWING COMPONENTS MAY VARY BETWEEN BOARDS 6021C AND 6021D. PRIOR TO REPLACING THESE COMPONENTS, OBSERVE THE BOARD MODEL NUMBER AND USE THE COMPONENTS SHOWN BELOW;

COMPONENT	6021C	6021D
R 25	1800 OHM, 2%	1000 OHM, 2%
R 30	1000 OHM	2700 OHM
R 31	2200 OHM	1800 OHM

8469 C 474

nt Board Schematic Diagram.

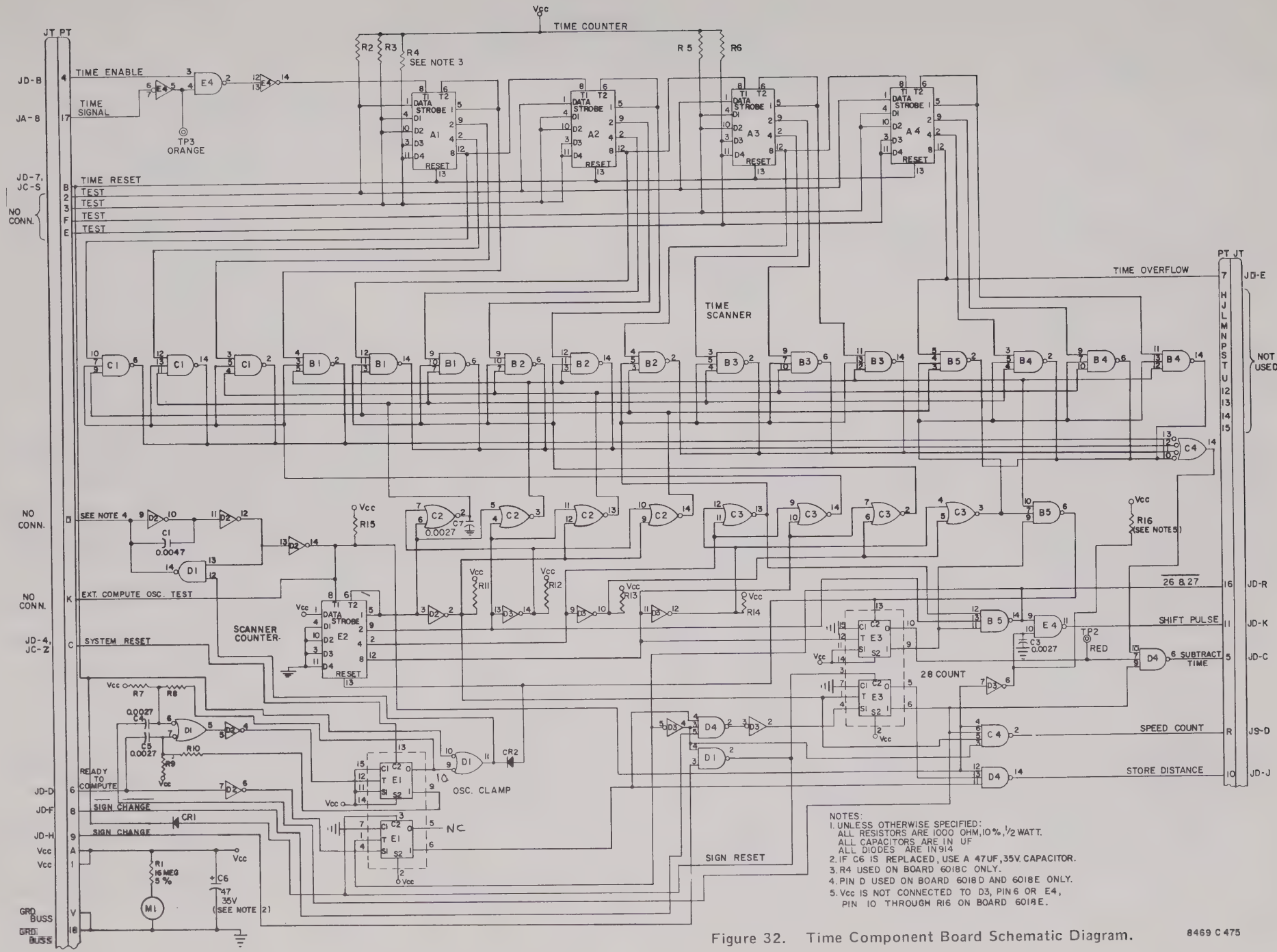
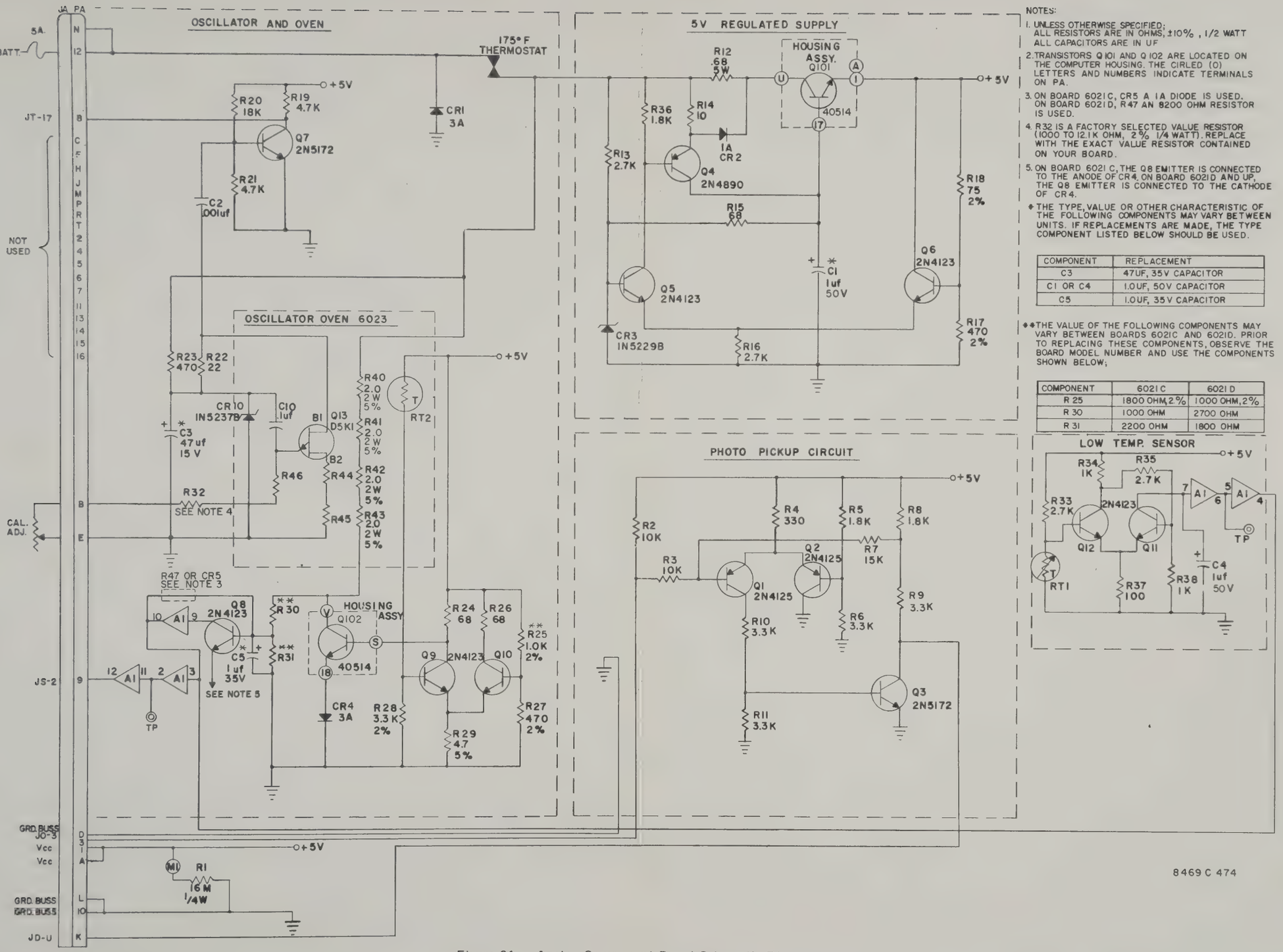


Figure 32. Time Component Board Schematic Diagram.

8469 C 475



NOTES:

1. UNLESS OTHERWISE SPECIFIED: ALL RESISTORS ARE IN OHMS, ±10% , 1/2 WATT ALL CAPACITORS ARE IN UF
2. TRANSISTORS Q101 AND Q102 ARE LOCATED ON THE COMPUTER HOUSING. THE CIRLED (O) LETTERS AND NUMBERS INDICATE TERMINALS ON PA.
3. ON BOARD 6021C, CR5 A 1A DIODE IS USED. ON BOARD 6021D, R47 AN 8200 OHM RESISTOR IS USED.
4. R32 IS A FACTORY SELECTED VALUE RESISTOR (1000 TO 12.1K OHM, 2% 1/4 WATT). REPLACE WITH THE EXACT VALUE RESISTOR CONTAINED ON YOUR BOARD.
5. ON BOARD 6021C, THE Q8 EMITTER IS CONNECTED TO THE ANODE OF CR4, ON BOARD 6021D AND UP, THE Q8 EMITTER IS CONNECTED TO THE CATHODE OF CR4.

♦ THE TYPE, VALUE OR OTHER CHARACTERISTIC OF THE FOLLOWING COMPONENTS MAY VARY BETWEEN UNITS. IF REPLACEMENTS ARE MADE, THE TYPE COMPONENT LISTED BELOW SHOULD BE USED.

COMPONENT	REPLACEMENT
C3	47UF, 35V CAPACITOR
C1 OR C4	1.0UF, 50V CAPACITOR
C5	1.0UF, 35V CAPACITOR

♦♦ THE VALUE OF THE FOLLOWING COMPONENTS MAY VARY BETWEEN BOARDS 6021C AND 6021D. PRIOR TO REPLACING THESE COMPONENTS, OBSERVE THE BOARD MODEL NUMBER AND USE THE COMPONENTS SHOWN BELOW;

COMPONENT	6021C	6021D
R 25	1800 OHM, 2%	1000 OHM, 2%
R 30	1000 OHM	2700 OHM
R 31	2200 OHM	1800 OHM

Figure 31. Analog Component Board Schematic Diagram.

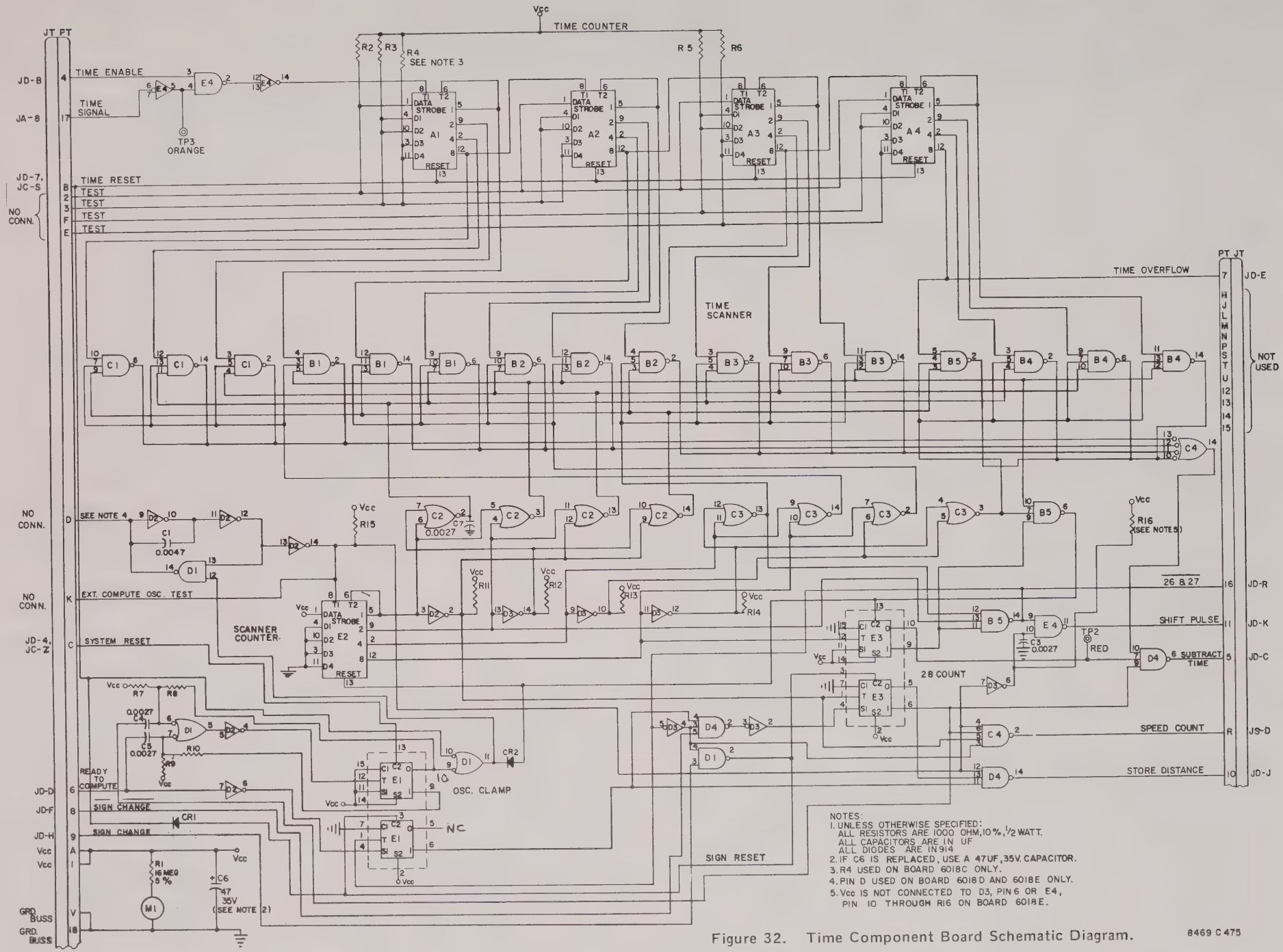
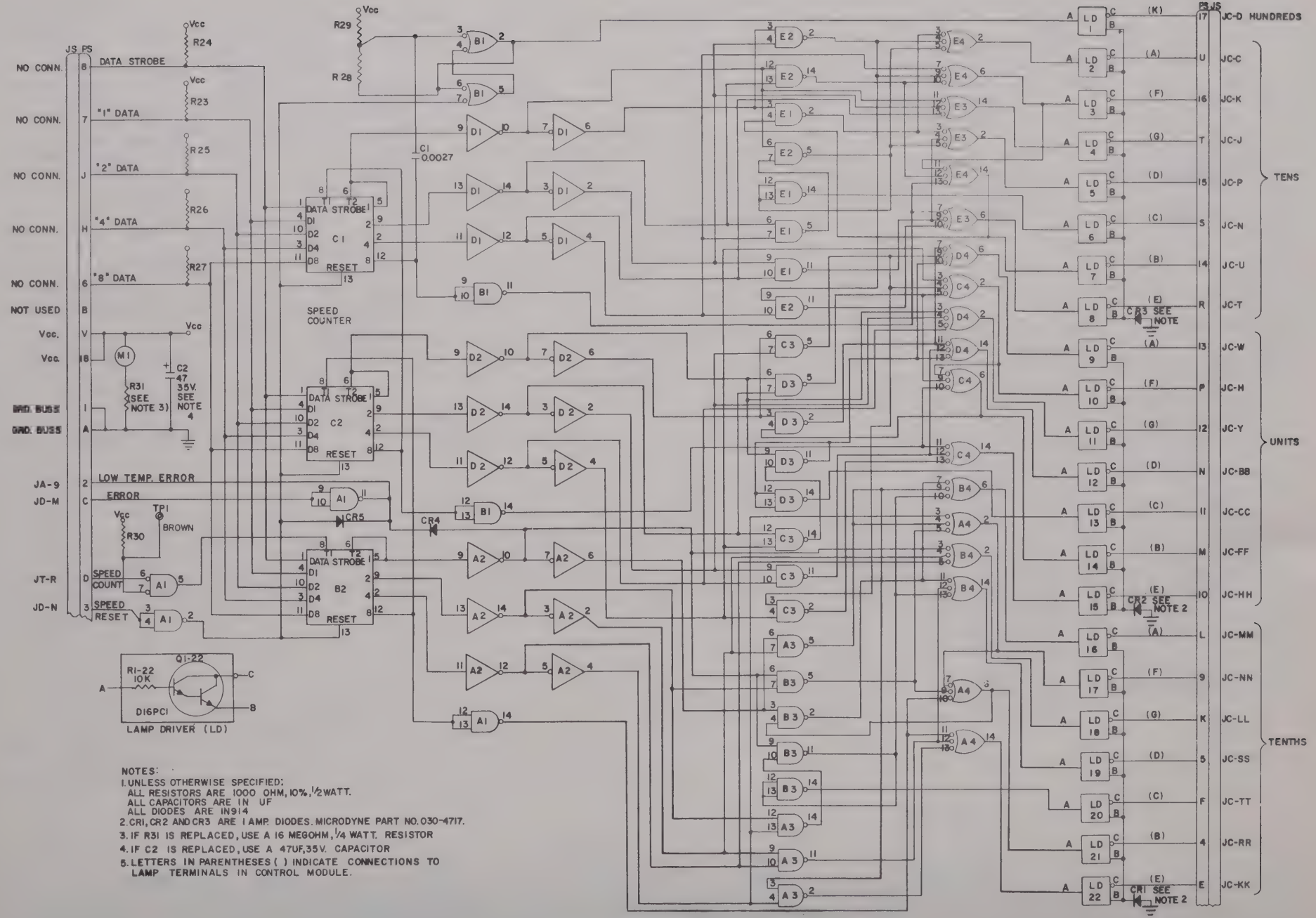


Figure 32. Time Component Board Schematic Diagram. 8469 C 475



NOTES:
1. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTORS ARE 1000 OHM, 10%, 1/2 WATT.
   ALL CAPACITORS ARE IN UF
   ALL DIODES ARE IN914
2. CR1, CR2 AND CR3 ARE 1 AMP. DIODES. MICRODYNE PART NO. 030-4717.
3. IF R31 IS REPLACED, USE A 16 MEGOHM, 1/4 WATT. RESISTOR
4. IF C2 IS REPLACED, USE A 47UF, 35V. CAPACITOR
5. LETTERS IN PARENTHESES ( ) INDICATE CONNECTIONS TO LAMP TERMINALS IN CONTROL MODULE.

Figure 33. Speed Component Board Schematic Diagram.

8469C476

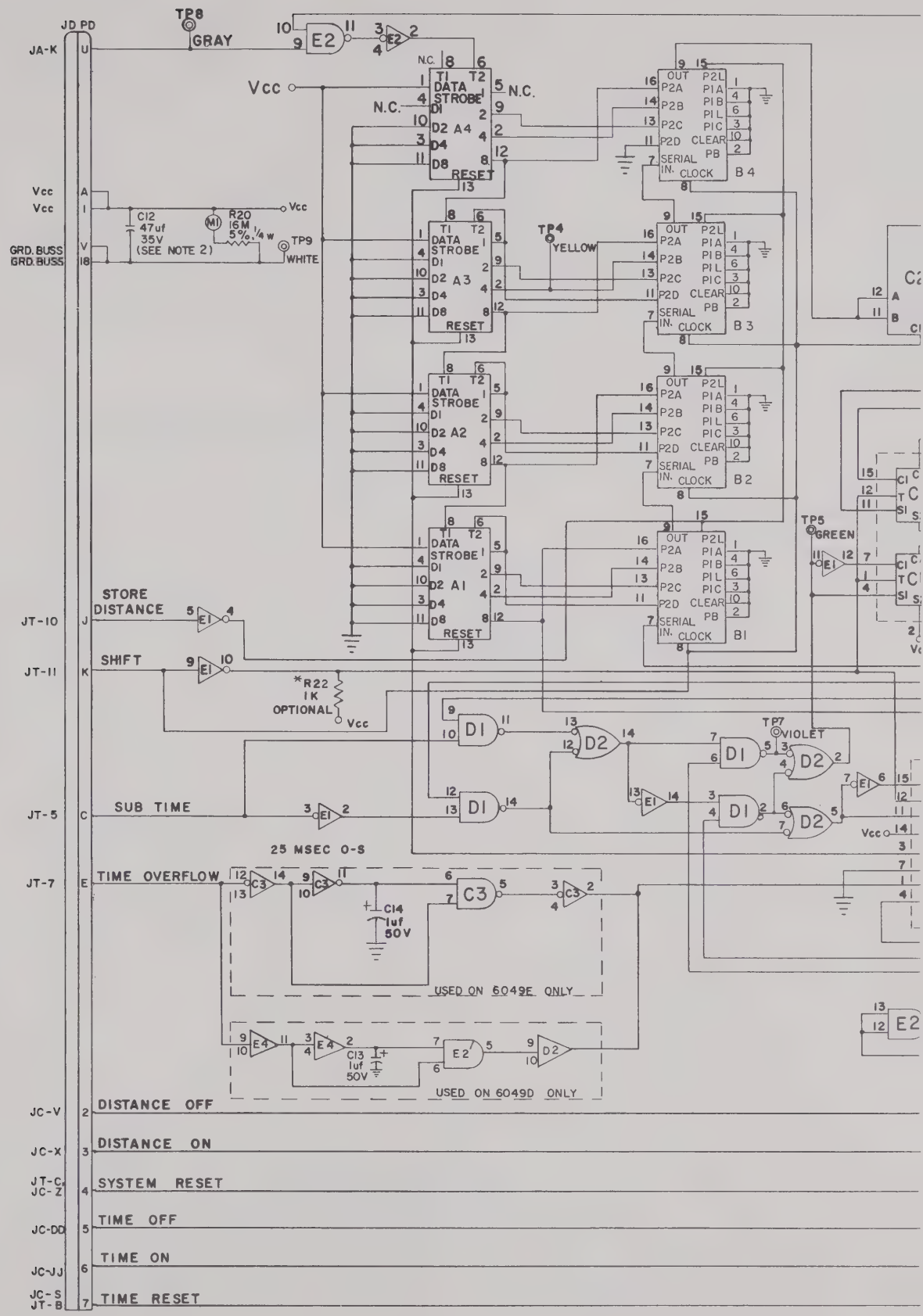
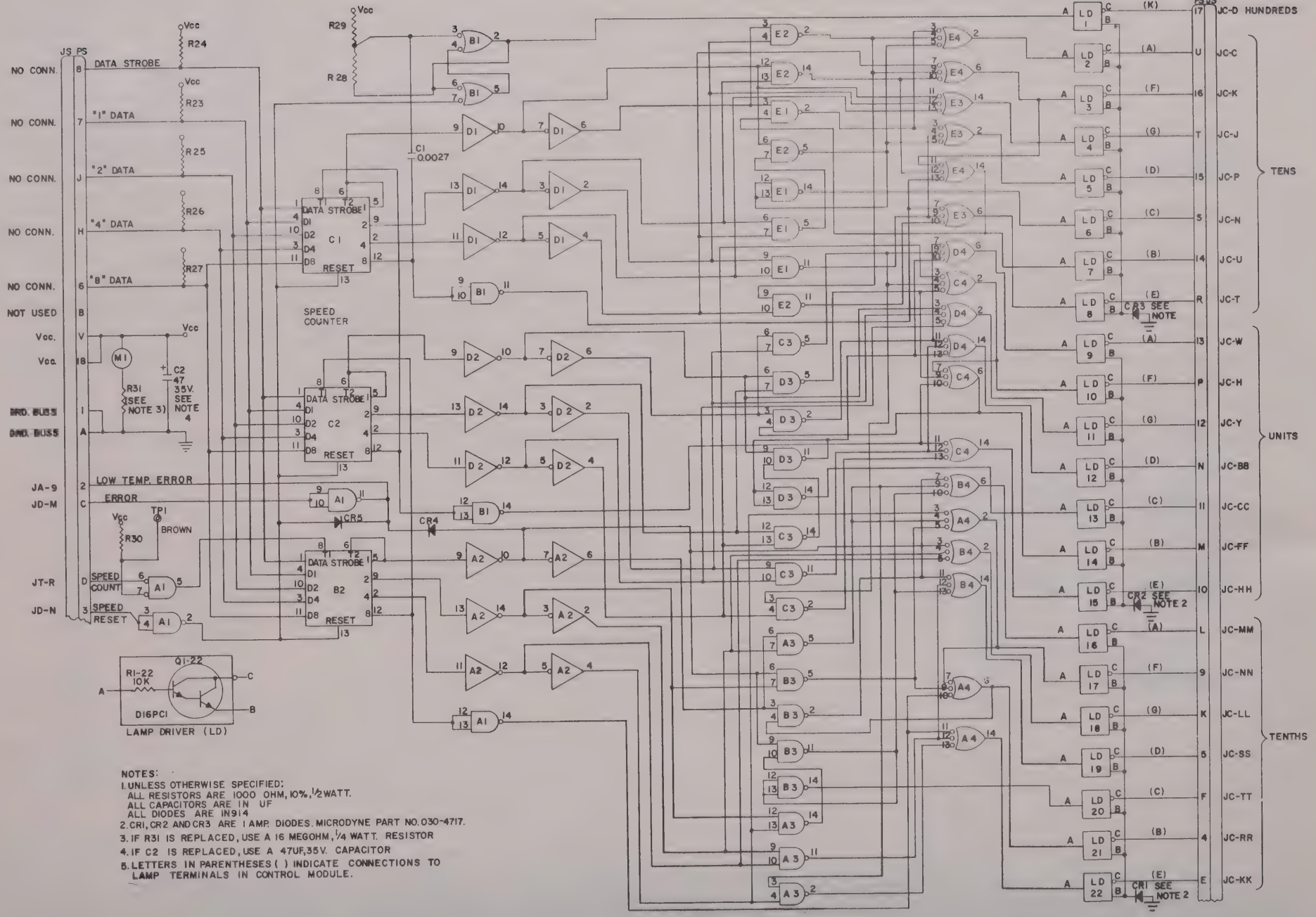


Figure 34B. Distance Component B



NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTORS ARE 1000 OHM, 10%, 1/2 WATT.
   ALL CAPACITORS ARE IN UF
   ALL DIODES ARE IN914
2. CR1, CR2 AND CR3 ARE 1 AMP. DIODES. MICRODYNE PART NO. 030-4717.
3. IF R31 IS REPLACED, USE A 16 MEGOHM, 1/4 WATT. RESISTOR
4. IF C2 IS REPLACED, USE A 47UF, 35V. CAPACITOR
5. LETTERS IN PARENTHESES ( ) INDICATE CONNECTIONS TO LAMP TERMINALS IN CONTROL MODULE.

Figure 33. Speed Component Board Schematic Diagram.

8469C476

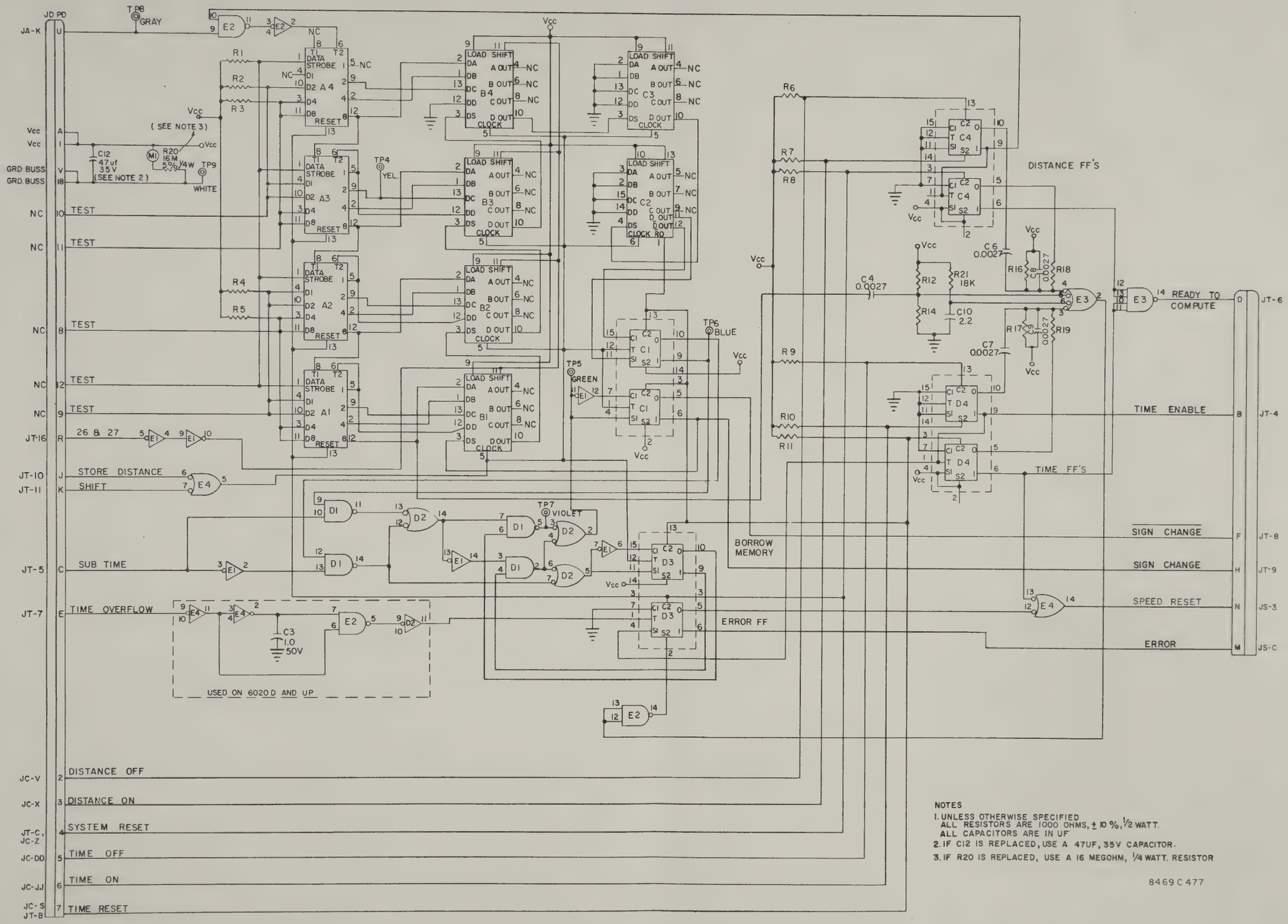
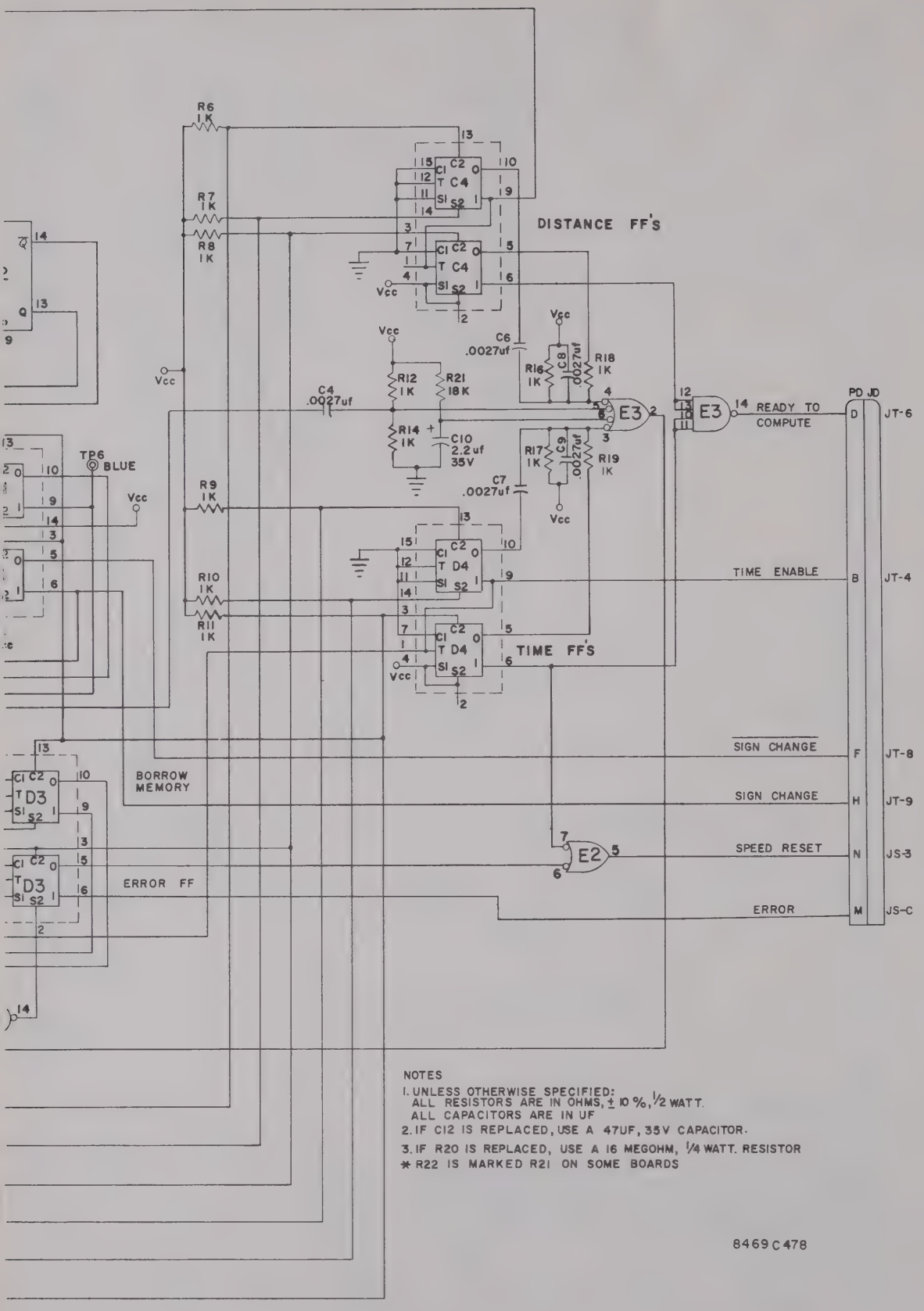


Figure 34A. Distance Component Board Schematic Diagram. Series 6020.



oard Schematic Diagram. Series 6049.

SECTION VI

PARTS LIST

Many of the components in the parts list are commercially available items. Where no part number is given for a part, it is suggested that the part be obtained at any local hardware or electronics supply house.

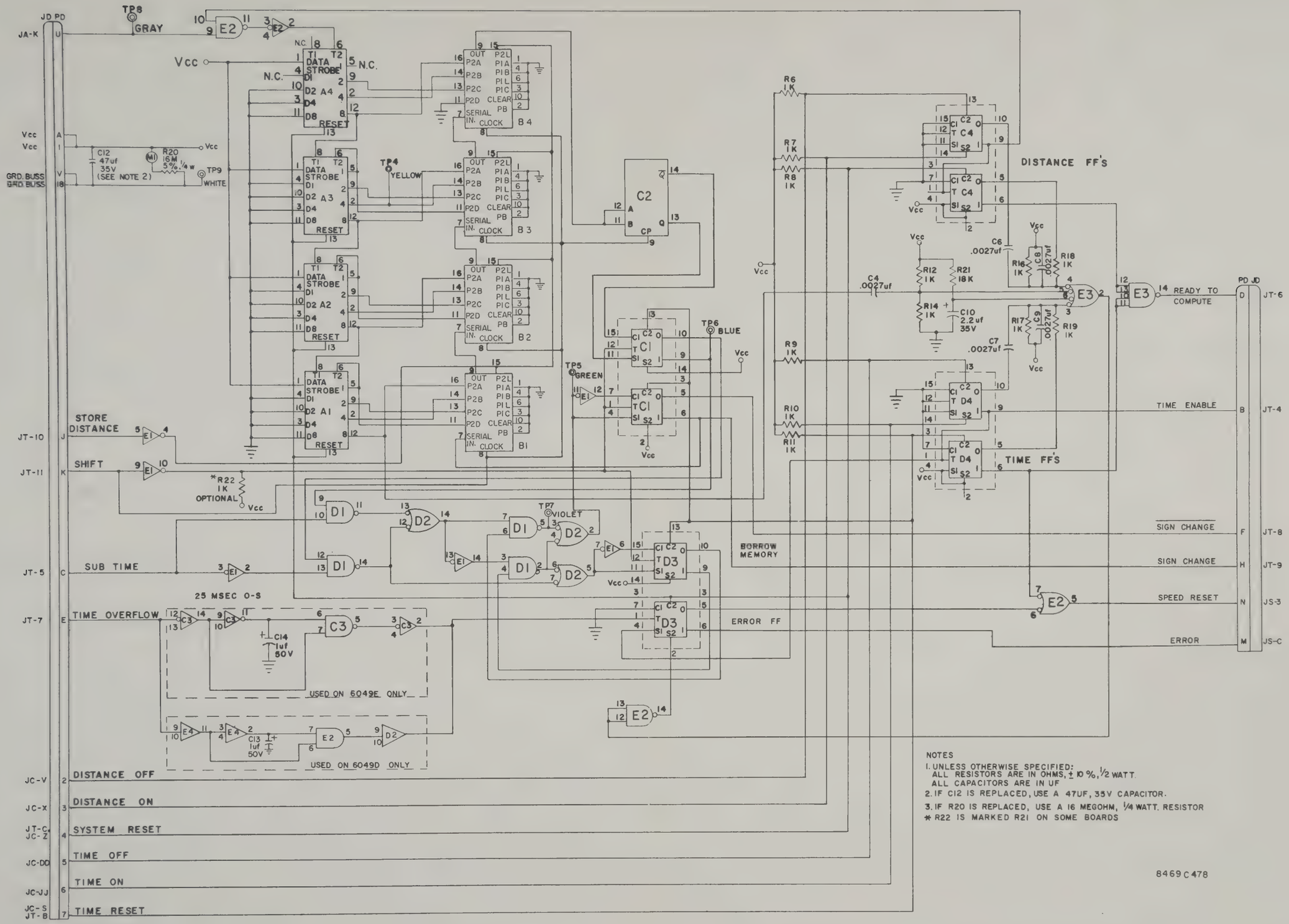
6–1. CONTROL MODULE.

FEDERAL PART NO. 8469D317 (figure 35)

Item	Federal Part No.	Description	Mfg. Name and No.
1	8469A67	Switch, pushbutton	Switchcraft, #903 (red)
2	8469A255	Readout	
3	8469A257	Switch, toggle	Cutler-Hammer, #8280K27H
4	8469A307	Housing assembly	
5	8469A265	Pivot, rod	
6	8469A266	Plate, locking	
7	7074A018	Lockwasher, 5/16"	
8	7058A011	Nut, hex, 5/16-18	
9	8469A264	Rod, floor mounting	
10	8469A263	Rod, dashboard mounting	
11	8469A303	Pivot, mounting stand	
12	8469A274	Knob	
13	8469C292	Plate, mounting	
14	8469A78	Potentiometer, dimmer	Ohmite, #D108
15	8469A305	Switch, toggle	Cutler-Hammer, #8868K4
16	8469A311	Potentiometer, calibration	Amphenol, #994L-203
17	8469A306	Terminal strip	H. H. Smith, #829
18	8469A293	Cover, grille	
19	8469A254	Connector, readout	
20	8469A294	Mounting bracket, cable	
21	8469A310	Strain relief	Heyco, #8-P1
22	8469A308	Cable	
23	8469A312	Connector	Elco, #00-8016-038-000-710
24	8469A270-1	Cover, lever (black)	Cutler-Hammer, #15PA90-4BK
25	8469A67-1	Switch, pushbutton	Switchcraft, #913 (black)
26	8469A270	Cover, lever (red)	Cutler-Hammer, #15PA90-4R
33	7000A40405	Screw, 6-32 x 5/16, PAN HD. (Phillips)	
34	7000A06108	Screw, 8-32 x $\frac{1}{2}$ RD. HD.	
35	7058A022	8-32 hex. nut	
36	8469A375	Resistor, 5.1 ohm, $5\frac{1}{4}$ watt	Ward Leonard, WL3X3

6–2. ODOMETER MODULE.

Because of the variety of automobiles, there are six basic types of Odometer Module fittings, hardware, etc. The make of vehicle and type of Odometer Module will determine which of the following parts lists and assembly drawings will be used.



NOTES

1. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTORS ARE IN OHMS, ± 10 %, ½ WATT
   ALL CAPACITORS ARE IN UF
2. IF C12 IS REPLACED, USE A 47UF, 35V CAPACITOR.
3. IF R20 IS REPLACED, USE A 16 MEGOHM, ¼ WATT. RESISTOR

* R22 IS MARKED R21 ON SOME BOARDS

8469C478

Figure 34B. Distance Component Board Schematic Diagram. Series 6049.

SECTION VI

PARTS LIST

Many of the components in the parts list are commercially available items. Where no part number is given for a part, it is suggested that the part be obtained at any local hardware or electronics supply house.

6–1. CONTROL MODULE.

FEDERAL PART NO. 8469D317 (figure 35)

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5	8469A265	Pivot, rod	
6	8469A266	Plate, locking	
7	7074A018	Lockwasher, 5/16"	
8	7058A011	Nut, hex, 5/16-18	
9	8469A264	Rod, floor mounting	
10	8469A263	Rod, dashboard mounting	
11	8469A303	Pivot, mounting stand	
12	8469A274	Knob	
13	8469C292	Plate, mounting	
14	8469A78	Potentiometer, dimmer	Ohmite, #D108
15	8469A305	Switch, toggle	Cutler-Hammer, #8868K4
16	8469A311	Potentiometer, calibration	Amphenol, #994L-203
17	8469A306	Terminal strip	H. H. Smith, #829
18	8469A293	Cover, grille	
19	8469A254	Connector, readout	
20	8469A294	Mounting bracket, cable	
21	8469A310	Strain relief	Heyco, #8-P1
22	8469A308	Cable	
23	8469A312	Connector	Elco, #00-8016-038-000-710
24	8469A270-1	Cover, lever (black)	Cutler-Hammer, #15PA90-4BK
25	8469A67-1	Switch, pushbutton	Switchcraft, #913 (black)
26	8469A270	Cover, lever (red)	Cutler-Hammer, #15PA90-4R
33	7000A40405	Screw, 6-32 x 5/16, PAN HD. (Phillips)	
34	7000A06108	Screw, 8-32 x $\frac{1}{2}$ RD. HD.	
35	7058A022	8-32 hex. nut	
36	8469A375	Resistor, 5.1 ohm, $5\frac{1}{4}$ watt	Ward Leonard, WL3X3

6–2. ODOMETER MODULE.

Because of the variety of automobiles, there are six basic types of Odometer Module fittings, hardware, etc. The make of vehicle and type of Odometer Module will determine which of the following parts lists and assembly drawings will be used.

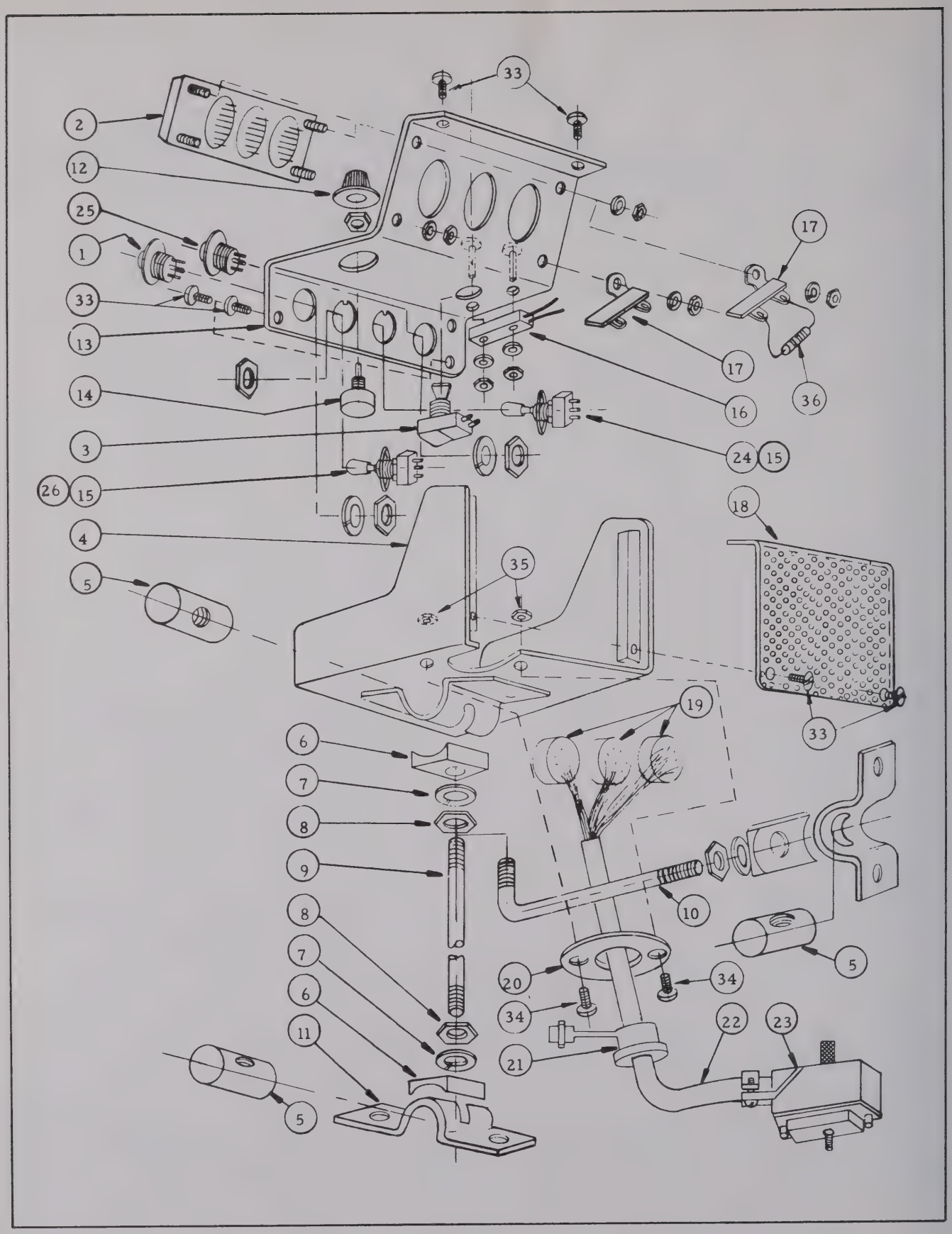

Figure 35. Control Module Assembly Drawing.

A. Chrysler Products and all G.M., except Oldsmobile and Chevrolet

(FEDERAL PART NO. 8469A366, figure 36).

Item	Federal Part No.	Description	Mfg. Name and No.
1	8469A320	Housing	
2	8469A328	Cover plate	
3	8469A348	Solder plate	
4	8469A327	Mounting board	
5	8469A334	Holder, diode	H. H. Smith, #430-103
6	8469A337	Duo-diode, photo	Texas Instruments, #H-38
7	8469A335	Terminal	Useco, #2030B
8	8469A342	Washer, wave spring	Geo. K. Garrett Co., #3W-364
9	8469A336	Lamp, light source	L. A. Miniature, #16L
10	8469A357	Insulator sleeve	
11	8469A341	Lampholder	Seastrom, #4521-12-20-1
12	8469A344	Rivet	
13	8469A339	Gasket	
14		6-32 x 5/16 FIL. HD. screw	
15	8469A338	Grommet	Accurate Products, #2110
16	8469A377	Grommet	
17	8469A59	Cable	
18	8469A346	Connector	ITT Cannon, #XLR-4-12C
19	8469A340	Retaining ring	Truarc, #N5000-75
20	8469A324	Shaft	
21	8469A333	Bearing	New Departure, #Z99R4A-XR1E
22	8469A325	Interrupter wheel	
23	8469A343	Retaining ring	Truarc, #5100-25
24	8469A353	Shaft assembly	
25	8469A321	Adapter bushing	

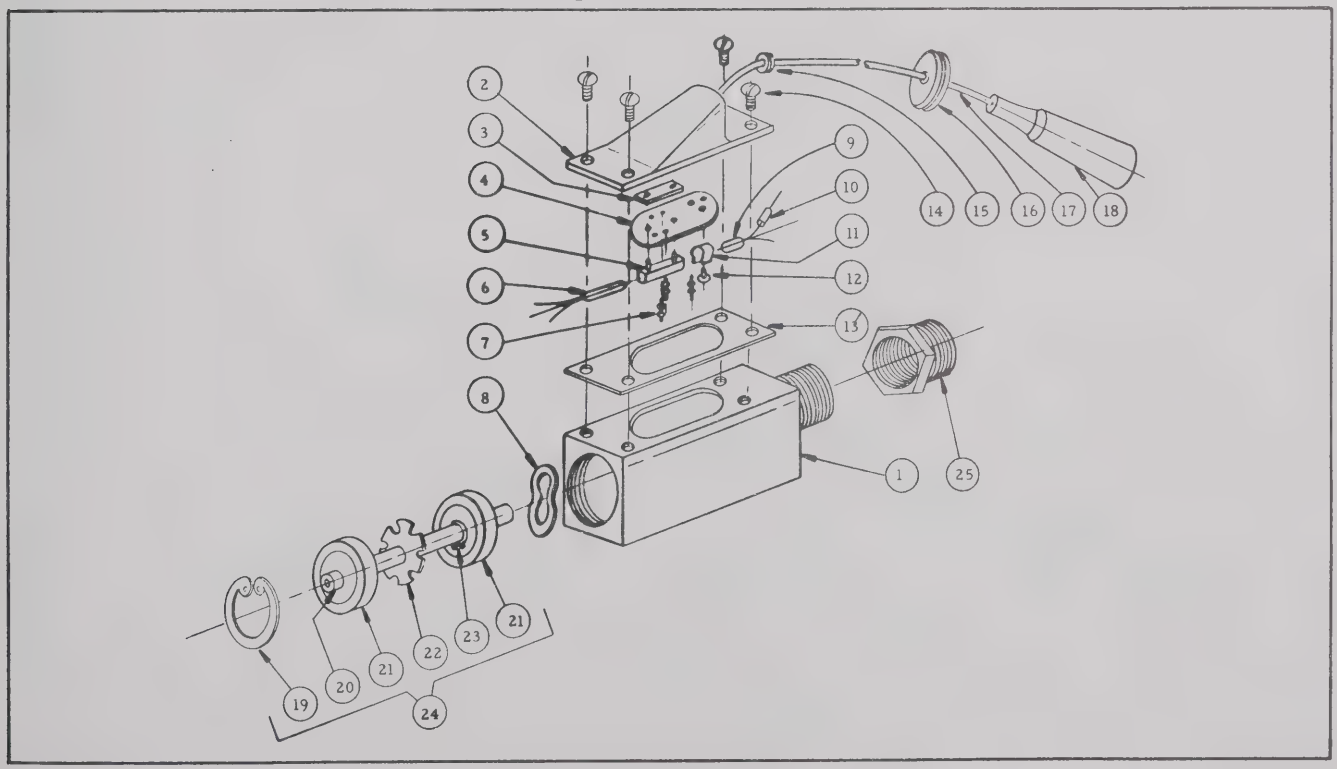

Figure 36. Odometer Module Assembly Drawing for Chrysler Products and All G.M., Except Oldsmobile and Chevrolet.

B. Chevrolet (FEDERAL PART NO. 8469A425, figure 37).

Item	Federal Part No.	Description	Mfg. Name and No.
1	8469A320	Housing	
2	8469A328	Cover plate	
3	8469A348	Solder plate	
4	8469A327	Mounting board	
5	8469A334	Holder, diode	H. H. Smith, #430-103
6	8469A337	Duo-diode, photo	Texas Instruments, #H-38
7	8469A335	Terminal	Useco, #2030B
8	8469A342	Washer, wave spring	Geo. K. Garrett Co., #3W-364
9	8469A336	Lamp, light source	L. A. Miniature, #16L
10	8469A357	Insulator sleeve	
11	8469A341	Lampholder	Seastrom, #4521-12-20-1
12	8469A344	Rivet	
13	8469A339	Gasket	
14		6-32 x 5/16 FIL. HD. screw	
15	8469A338	Grommet	Accurate Products, #2110
16	8469A377	Grommet	
17	8469A59	Cable	
18	8469A346	Connector	ITT Cannon, #XLR-4-12C
19	8469A340	Retaining ring	Truarc, #N5000-75
20	8469A324	Shaft	
21	8469A333	Bearing	New Departure, #Z99R4A-XR1E
22	8469A325	Interrupter wheel	
23	8469A343	Retaining ring	Truarc, #5100-25
33	8469A422	Adapter plug	

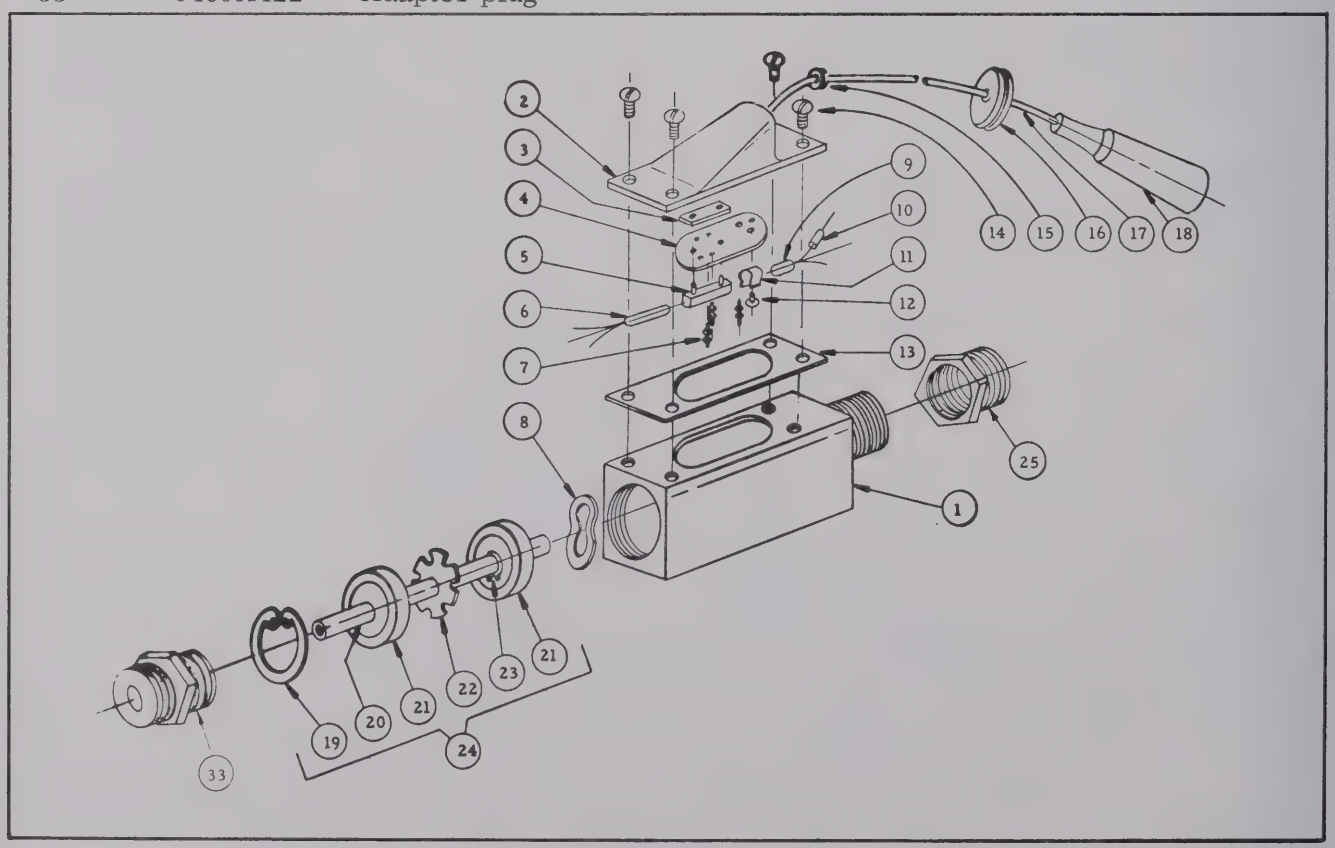

Figure 37. Odometer Module Assembly Drawing for Chevrolet.

C. Oldsmobile (FEDERAL PART NO. 8469A368, figure 38).

Item	Federal Part No.	Description	Mfg. Name and No.
1	8469A320	Housing	
2	8469A328	Cover plate	
3	8469A348	Solder plate	
4	8469A327	Mounting board	
5	8469A334	Holder, diode	H. H. Smith, #430-103
6	8469A337	Duo-diode, photo	Texas Instruments, #H-38
7	8469A335	Terminal	Useco, #2030B
8	8469A342	Washer, wave spring	Geo. K. Garrett Co., #3W-364
9	8469A336	Lamp, light source	L.A. Miniature, #16L
10	8469A357	Insulator sleeve	
11	8469A341	Lampholder	Seastrom, #4521-12-20-1
12	8469A344	Rivet	
13	8469A339	Gasket	
14		6-32 x 5/16 FIL. HD. screw	
15	8469A338	Grommet	Accurate Products, #2110
16	8469A377	Grommet	
17	8469A59	Cable	
18	8469A346	Connector	ITT Cannon, #XLR-4-12C
19	8469A340	Retaining ring	Truarc, #N5000-75
20	8469A329	Shaft	
21	8469A333	Bearing	New Departure, #Z99R4A-XR1E
22	8469A326	Interrupter wheel	
23	8469A343	Retaining ring	Truarc, #5100-25
24	8469A355	Shaft assembly	
25	8469A323	Adapter plug	
26	8469A369	Speedometer cable	

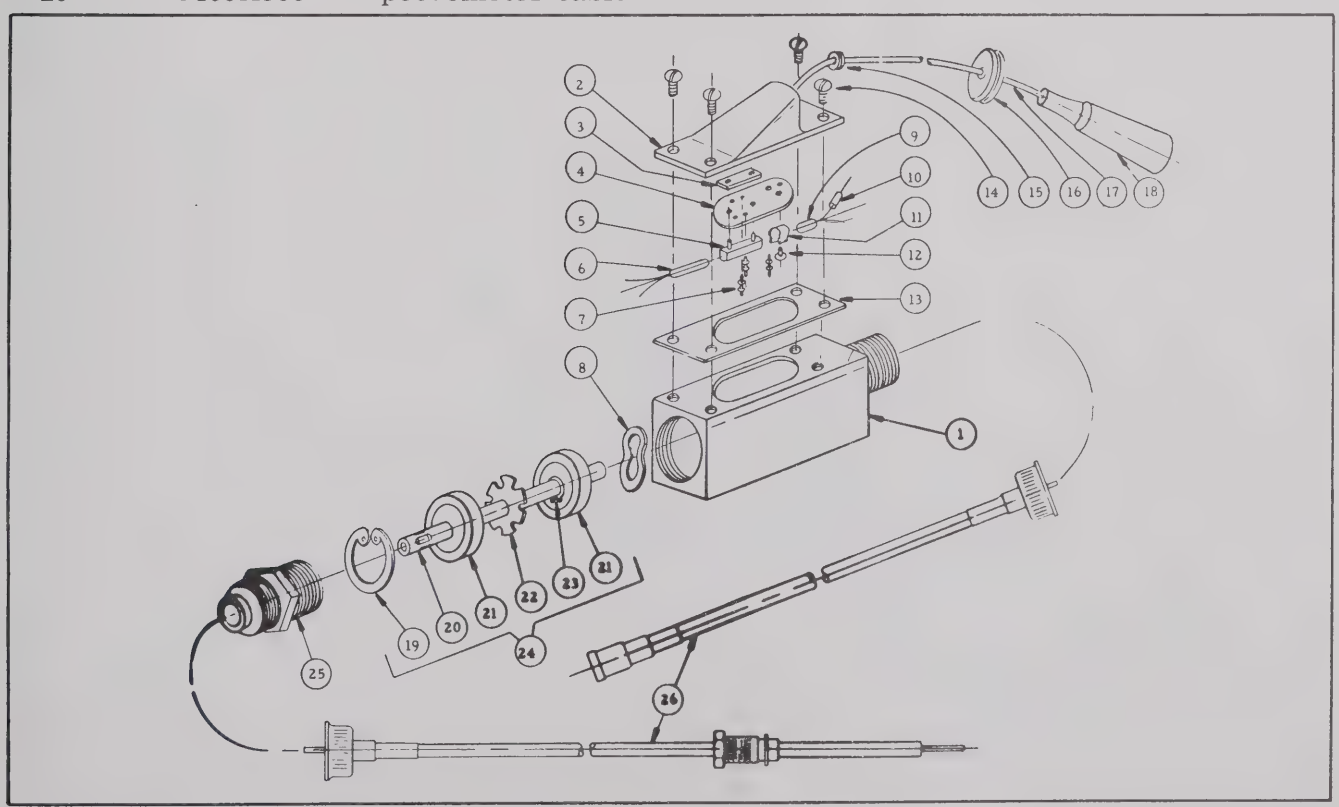

Figure 38. Odometer Module Assembly Drawing for Oldsmobile.

D. Ford Products - Transmission Mount (FEDERAL PART NO. 8469A365, figure 39).

Item	Federal Part No.	Description	Mfg. Name and No.
1	8469A320	Housing	
2	8469A328	Cover plate	
3	8469A348	Solder plate	
4	8469A327	Mounting board	
5	8469A334	Holder, diode	H. H. Smith, #430-103
6	8469A337	Duo diode, photo	Texas Instruments, #H-38
7	8469A335	Terminal	Useco, #2030B
8	8469A342	Washer, wave spring	Geo. K. Garrett Co., #3W-364
9	8469A336	Lamp, light source	L.A. Miniature, #16L
10	8469A357	Insulator sleeve	
11	8469A341	Lampholder	Seastrom, #4521-12-20-1
12	8469A344	Rivet	
13	8469A339	Gasket	
14		6-32 x 5/16 FIL. HD. screw	
15	8469A338	Grommet	Accurate Products, #2110
16	8469A377	Grommet	
17	8469A59	Cable	
18	8469A346	Connector	ITT Cannon, #XLR-4-12C
19	8469A340	Retaining ring	Truarc, #N5000-75
20	8469A324	Shaft	
21	8469A333	Bearing	New Departure, #Z99R4A-XR1E
22	8469A325	Interrupter wheel	
23	8469A343	Retaining ring	Truarc, #5100-25
24	8469A353	Shaft assembly	

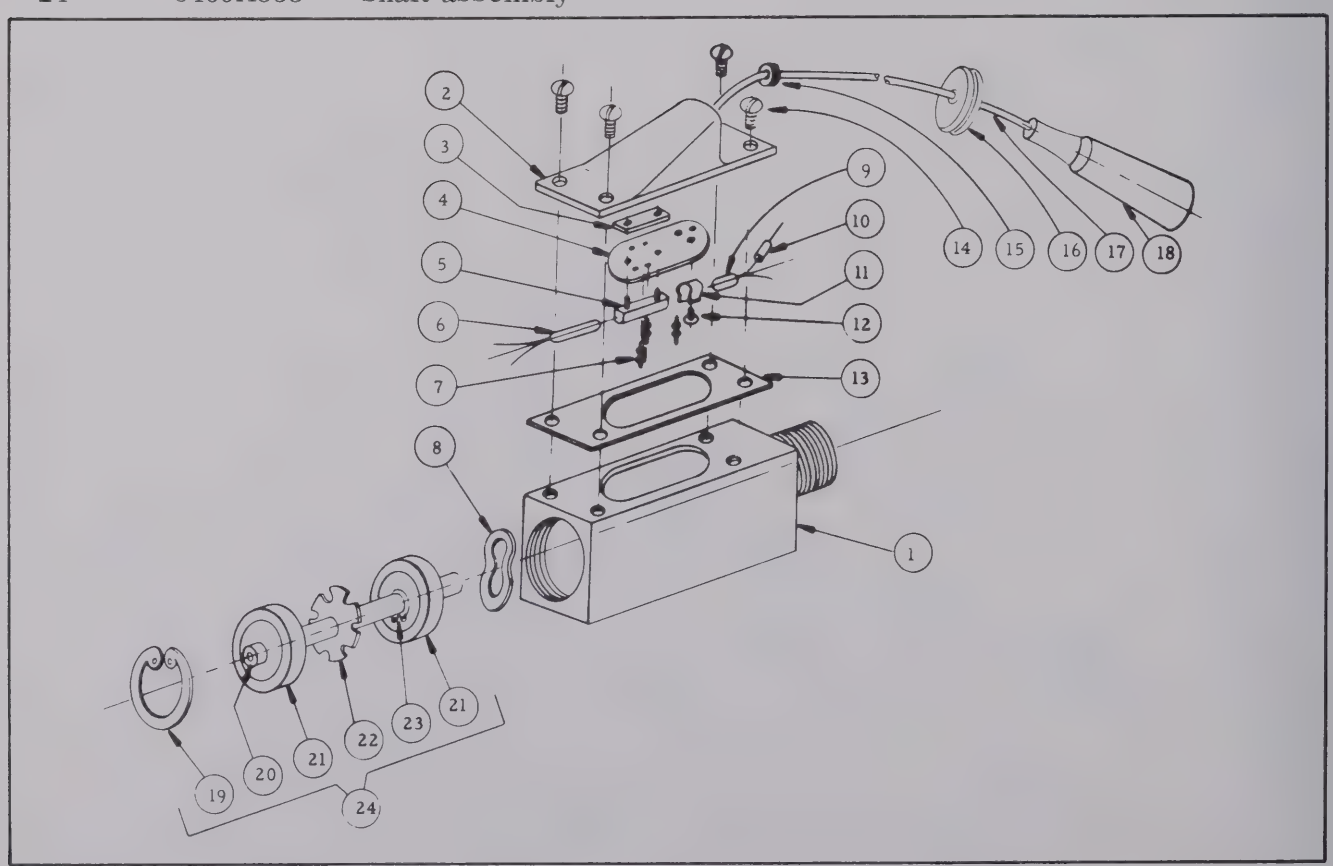

Figure 39. Odometer Module Assembly Drawing for Ford Products (Transmission Mount).

E. Ford Products - Two-Piece Cable (FEDERAL PART NO. 8469A367, figure 40).

Item	Federal Part No.	Description	Mfg. Name and No.
1	8469A320	Housing	
2	8469A328	Cover plate	
3	8469A348	Solder plate	
4	8469A327	Mounting board	
5	8469A334	Holder, diode	H. H. Smith, #430-103
6	8469A337	Duo diode, photo	Texas Instruments, #H-38
7	8469A335	Terminal	Useco, #2030B
8	8469A342	Washer, wave spring	Geo. K. Garrett Co., #3W-364
9	8469A336	Lamp, light source	L. A. Miniature, #16L
10	8469A357	Insulator sleeve	
11	8469A341	Lampholder	Seastrom, #4521-12-20-1
12	8469A344	Rivet	
13	8469A339	Gasket	
14		6-32 x 5/16 FIL. HD. screw	
15	8469A338	Grommet	Accurate Products, #2110
16	8469A377	Grommet	
17	8469A59	Cable	
18	8469A346	Connector	ITT Cannon, #XLR-4-12C
19	8469A340	Retaining ring	Truarc, #N5000-75
20	8469A329	Shaft	
21	8469A333	Bearing	New Departure, #Z99R4A-XR1E
22	8469A325	Interrupter wheel	
23	8469A343	Retaining ring	Truarc, #5100-25
24	8469A354	Shaft assembly	
25	8469A323	Adapter plug	

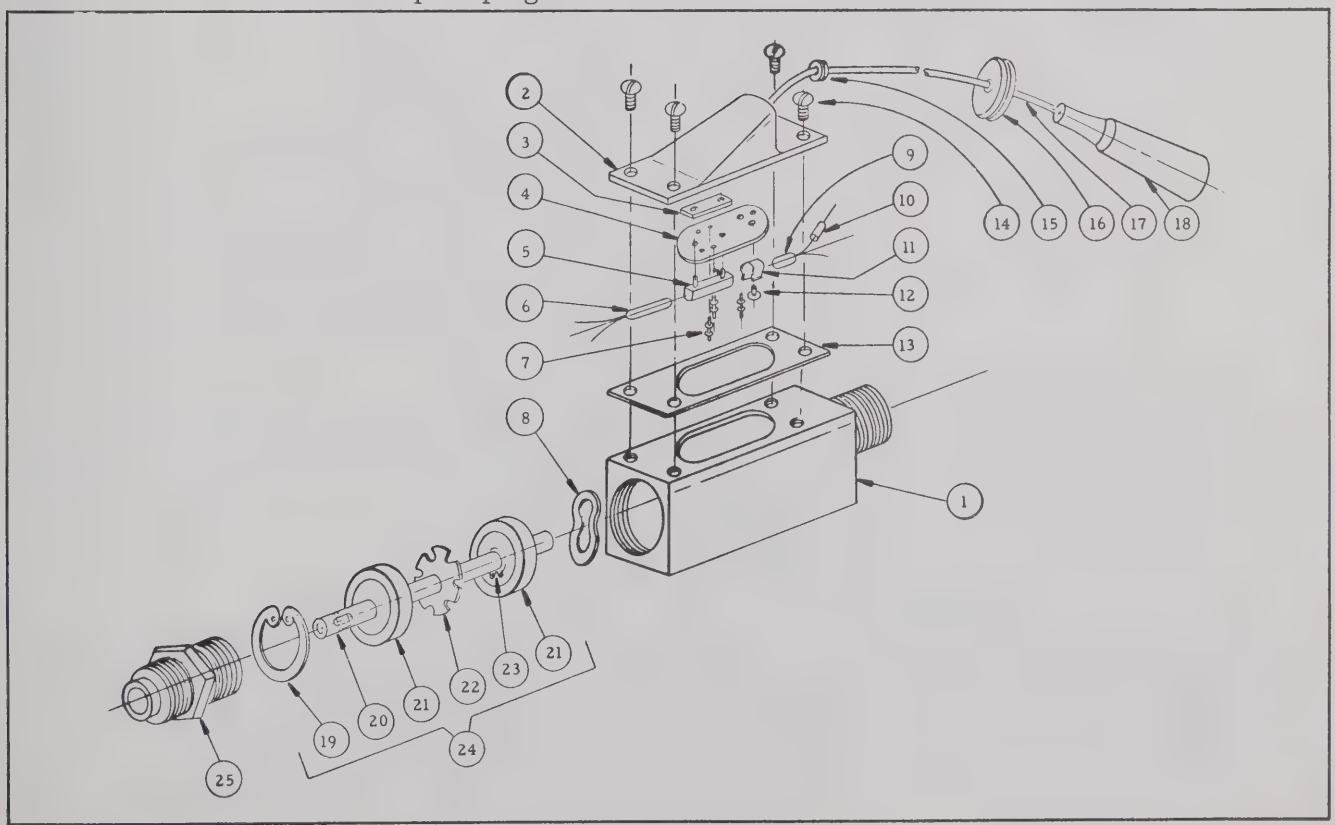

Figure 40. Odometer Module Assembly Drawing for Ford Products (Two—piece Cable).

F. Chrysler Products - Two-Piece Cable (FEDERAL PART NO. 8469A362, figure 41).

Item	Federal Part No.	Description	Mfg. Name and No.
1	8469A320	Housing	
2	8469A328	Cover plate	
3	8469A348	Solder plate	
4	8469A327	Mounting board	
5	8469A334	Holder, diode	H. H. Smith, #430-103
6	8469A337	Duo-diode, photo	Texas Instruments, #H-38
7	8469A335	Terminal	Useco, #2030B
8	8469A342	Washer, wave spring	Geo. K. Garrett Co., #3W-364
9	8469A336	Lamp, light source	L. A. Miniature, #16L
10	8469A357	Insulator sleeve	
11	8469A341	Lampholder	Seastrom, #4521-12-20-1
12	8469A344	Rivet	
13	8469A339	Gasket	
14		6-32 x 5/16 FIL. HD. screw	
15	8469A338	Grommet	Accurate Products, #2110
16	8469A377	Grommet	
17	8469A59	Cable	
18	8469A346	Connector	ITT Cannon, #XLR-4-12C
19	8469A340	Retaining ring	Truarc, #N5000-75
20	8469A324	Shaft	
21	8469A333	Bearing	New Departure, #Z99R4A-XR1E
22	8469A325	Interrupter wheel	
23	8469A343	Retaining ring	Truarc, #5100-25
24	8469A353	Shaft assembly	
25	8469A321	Adapter bushing	

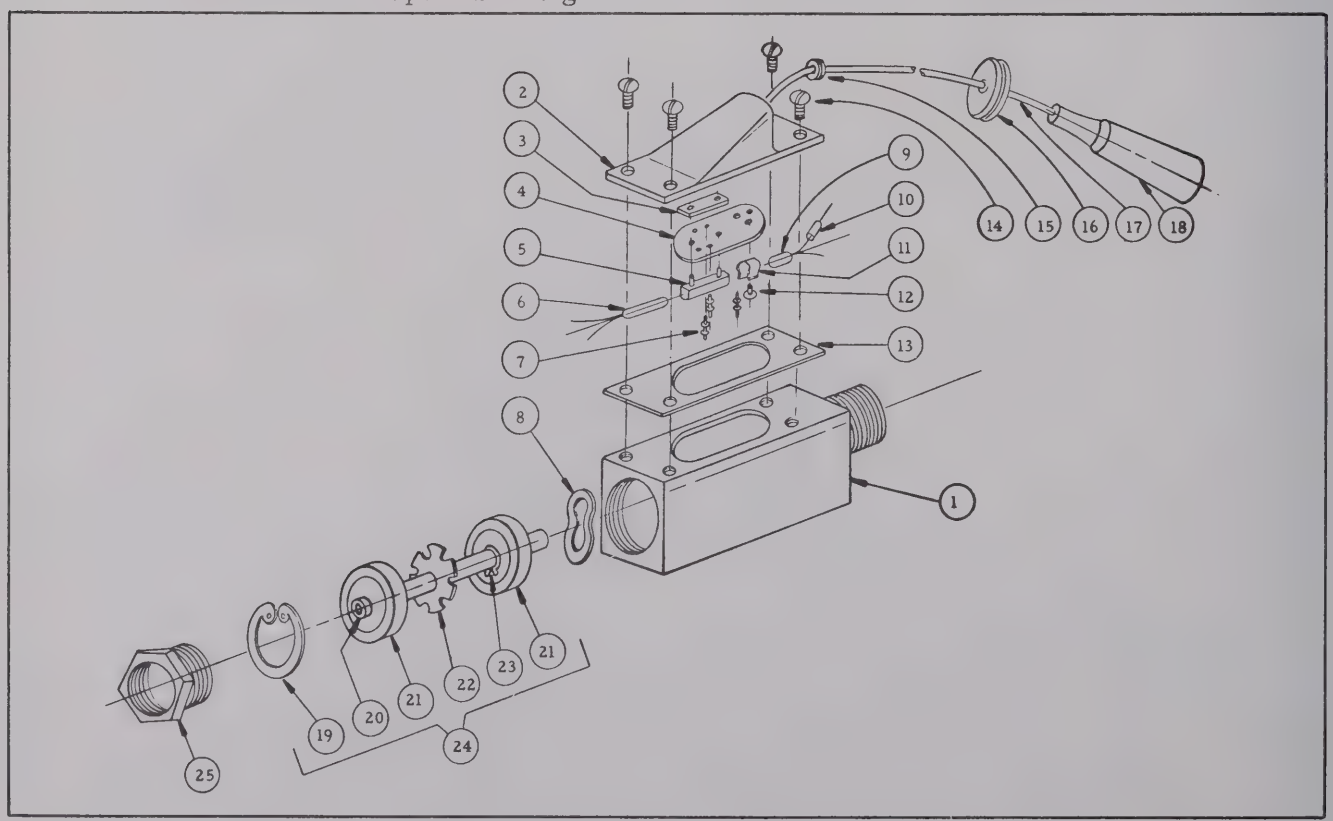

Figure 41. Odometer Module Assembly Drawing for Chrysler Products (Two—piece Cable).

6–3. COMPUTER MODULE.

FEDERAL PART NO. 8469C401, see figure 42.

Item	Federal Part No.	Description	Mfg. Name and No.
1	8469C468	Housing	
2	8469B469	Housing, bottom	
3	8469A470	Plate, inspection	
4	8469B471	Heat sink	
5		Transistor, power	RCA, #40514
6		Fuse holder	Buss, #342014
7		Receptacle, power	Cinch-Jones, #P-302AB
8		Fuse, 5 ampere, 3 AG	
9		Receptacle, odometer	Cannon, #XLR-4-31
10		Nameplate	
11		Spacer, heat sink (part of item 1)	
12		Transistor, power	RCA, #40514
13	8469B458	Component board, speed	
14	8469B459	Component board, time	
15	8469B460	Component board, distance	
16	8469B461	Component board, analog	
17	8469B462	Board, mother	
18	8469A472	Bracket, mounting	
19	8469A473	Strip, bumper	
20		Screw, 4-40 x 5/16	
21		Screw, 4-40 x $\frac{1}{4}$	
22		Screw, 4-40 x 5/16	
23		Screw, 8-32 x $\frac{1}{4}$	
24		Screw, 4-40 x 5/16	
25		Screw, 8-32 x 3/8	
26		Screw, 4-40 x 5/16, flat head	
27		Lockwasher, #8	
28		Lockwasher, #4	
29		Washer, #8	
30		Washer, #4	

NOTE: Unless otherwise specified, all screws are binder head.

6–4. COMPUTER MODULE COMPONENT BOARDS.

The road map style used for integrated circuit location (refer to paragraph 5-4, D), along with the standard abbreviation for capacitors (C) has resulted in the same symbol being used for entirely different components. To avoid confusion in the parts list, the capacitor abbreviation will be followed by a dash (-).

Example: C -1 is a capacitor
C1 is an integrated circuit in the first row of column C

Integrated circuits used on the component boards are checked at the factory to ensure operation in the -40°C to +80°C temperature range. These parts are ordinarily rated by the manufacturer at 0°C to +75°C. When ordering from the component manufacturer, obtain the Military equivalent component or ensure that the component will operate between -40°C to +80°C.

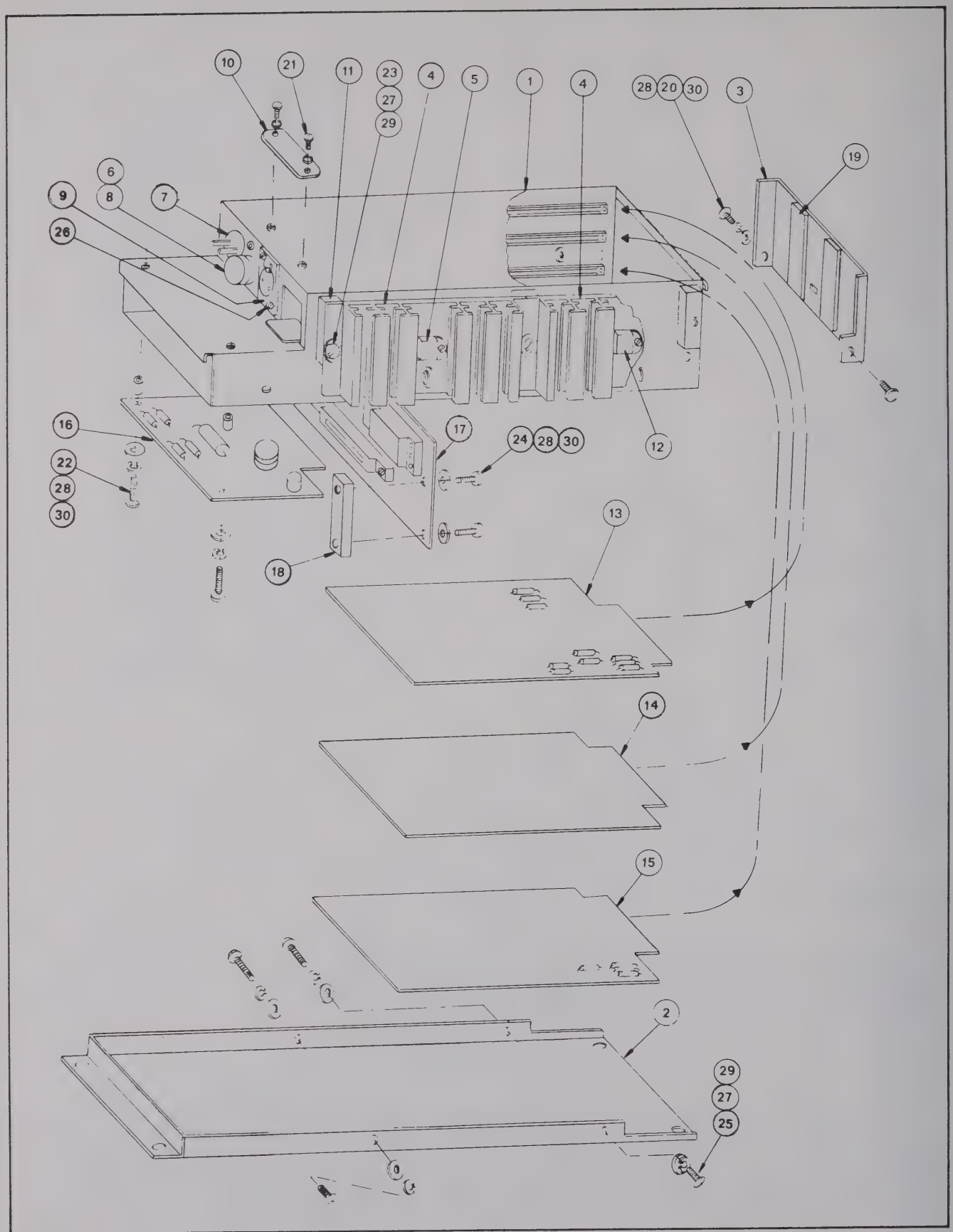

Figure 42. Computer Module Assembly Drawing.

A. Analog Component Board (6021C and 6021D). See figure 43.

Item	Symbol	Description and Manufacturer
1		Oscillator Oven
2	R*31	Resistor, Carbon, 2200 Ohm, 10%, $\frac{1}{2}$W
3	R*30,34,38	Resistor, Carbon, 1000 Ohm, 10%, $\frac{1}{2}$W
4	R6,9,10,11	Resistor, Carbon, 3300 Ohm, 10%, $\frac{1}{2}$W
5	R17,27	Resistor, 470 Ohm, 2%
6	A1	Integrated Circuit. Signetics SP690A
7	C-5	Capacitor, Tantalum, 1.0 UF, 35 V
8	Q5,6,8,9,10,11,12	Transistor, NPN, 2N4123
9	CR1,4	Diode, Silicon Rectifier, 3 Amp.
10	R**47	Resistor, Carbon, 8200 Ohm, 10%, $\frac{1}{2}$W
11	CR2,*5	Diode, Silicon Rectifier, 1 Amp. Power Components
12	R18	Resistor, 75 Ohm, 2%
13	R13,16,**30,33,35	Resistor, Carbon, 2700 Ohm, 10%, $\frac{1}{2}$W
14	R15,24,26	Resistor, Carbon, 68 Ohm, 10%, $\frac{1}{2}$W
15	CR3	Diode, Zener, IN5229B
16	R12	Resistor, 0.68 Ohm, 5W
17	R*25	Resistor, 1800 Ohm, 2%
18	R14	Resistor, Carbon, 10 Ohm, 10%, $\frac{1}{2}$W
19	R5,8,**31,36	Resistor, Carbon, 1800 Ohm, 10%, $\frac{1}{2}$W
20	Q4	Transistor, PNP, 2N4890
21	R29	Resistor, Carbon, 4.7 Ohm, 5%, $\frac{1}{2}$W
22		Thermostat, 175^{O}F. Penn Electric Tech. Inc., Type IT
23	R1	Resistor, Carbon, 16 Megohm, 5%, $\frac{1}{4}$W
24	Q3,7	Transistor, NPN, 2N5172
25	R2,3	Resistor, Carbon, 10K Ohm, 10%, $\frac{1}{2}$W
26	R7	Resistor, Carbon, 15K Ohm, 10%, $\frac{1}{2}$W
27	R4	Resistor, Carbon, 330 Ohm, 10%, $\frac{1}{2}$W
28	Q1,2	Transistor, PNP, 2N4125
29	RT1	Thermister
30	R37	Resistor, Carbon, 100 Ohm, 10%, $\frac{1}{2}$ W
31	R20	Resistor, Carbon, 18K Ohm, 10%, $\frac{1}{2}$ W
32	R19,21	Resistor, Carbon, 4700 Ohm, 10%, $\frac{1}{2}$W
33	C-2	Capacitor, Tantalum, 0.001 UF
34	R22	Resistor, Carbon, 22 Ohm, 10%, $\frac{1}{2}$W
35	C-3	Capacitor, Tantalum, 47 UF, 35 V
36	R32	Factory Selected Value. 1000 to 12.1K Ohm, 2%, $\frac{1}{4}$W Use exact replacement.
37	R**25	Resistor, 1000 Ohm, 2%
38	R23	Resistor, Carbon, 470 Ohm, 10%, $\frac{1}{2}$W
39	R28	Resistor, Carbon, 3300 Ohm, 2%, $\frac{1}{2}$W
40	M1	Meter, Elapsed Time. Curtis Meter No. 10980
41		Printed Circuit Board with components. Federal,8469B461
42	C-1,4	Capacitor, Tantalum, 1.0 UF, 50 V

* Indicates used on 6021C only.
** Indicates used on 6021D only.

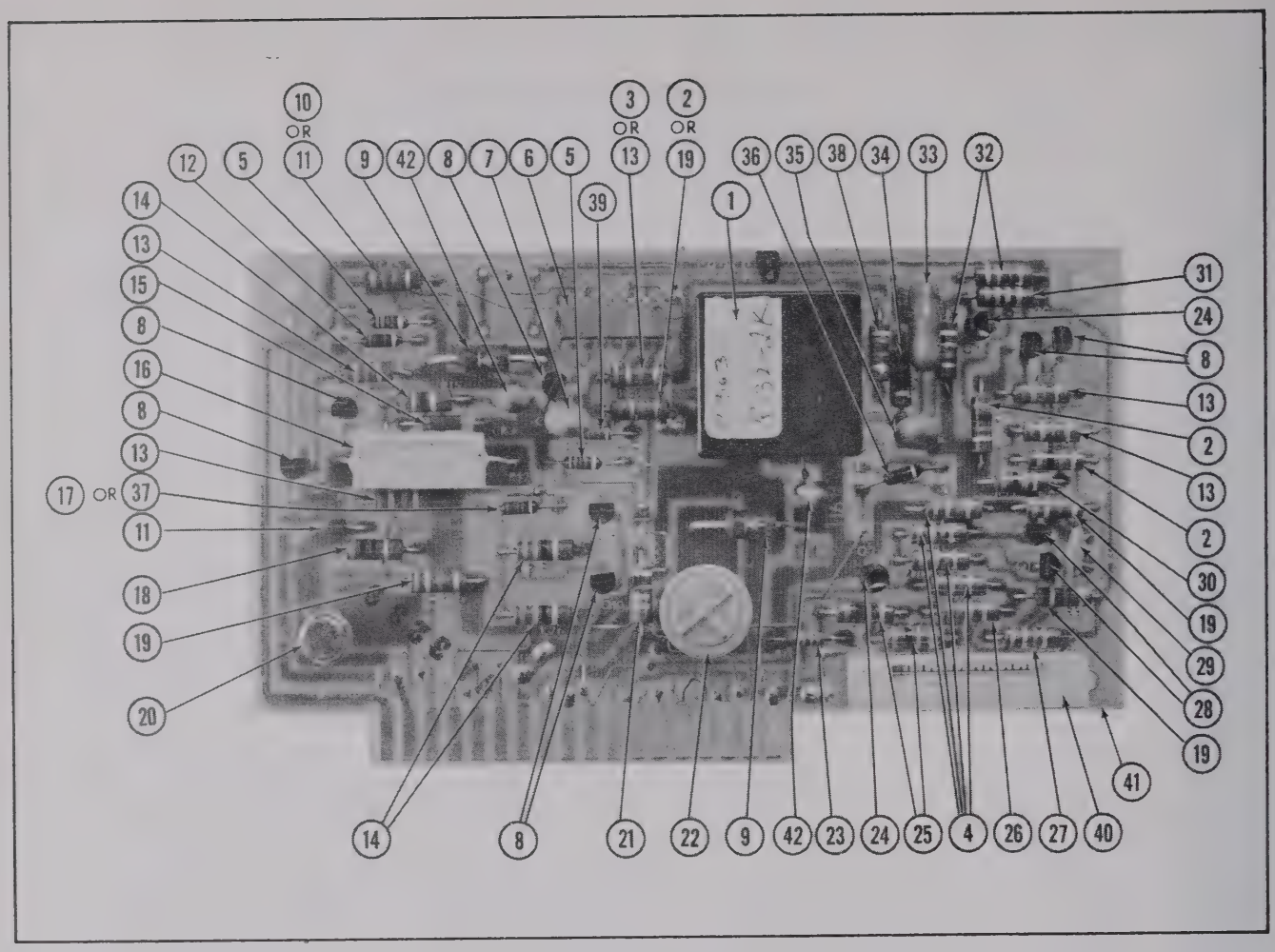

Figure 43. Analog Component Board Assembly Drawing.

B. Time Component Board (6018). See figure 44.

Item	Symbol	Description and Manufacturer
1	CR1,2	Diode, Type IN914
2	D1, E4	Integrated Circuit, Signetics, SP387A
3	R2 thru R15	Resistor, Carbon, 1000 Ohm, 10%, $\frac{1}{2}$W
4	C-3,4,5,7	Capacitor, Ceramic Disc, 0.0027 UF
5	E1, E3	Integrated Circuit. Signetics, SP322B
6	TP2,3	Test Jack. Amp #3-582118 (state color)
7	A1,A2,A3,A4, E2	Integrated Circuit, Signetics, N8281A
8	D2,D3	Integrated Circuit. Signetics, SP690A
9	C-1	Capacitor, Tantalum, 0.0047 UF
10	B1,B2,B3,B4,B5, C1,D4	Integrated Circuit. Signetics, SP377A
11	R1	Resistor, Carbon, 16 Megohm, 5%, $\frac{1}{4}$W
12	M1	Meter, Elapsed Time. Curtis Meter No. 10980
13	C-6	Capacitor, Tantalum, 47 UF, 35V
14		Printed Circuit Board with components. Federal,8469B459
15	C2,C3	Integrated Circuit. Signetics, SP380A
16	C4	Integrated Circuit. Signetics, SP337A

C. Speed Component Board (6019). See figure 45.

Item	Symbol	Description and Manufacturer
1	A1,A3,B1,B3,C3, D3,E1,E2	Integrated Circuit. Signetics, SP387A
2	A4,B4,C4,D4,E3, E4	Integrated Circuit. Signetics, SP377A
3	B2,C1,C2	Integrated Circuit. Signetics, N8280A
4	A2,D1,D2	Integrated Circuit. Signetics, SP690A
5	R23 thru R30	Resistor, Carbon, 1000 Ohm, 10%, $\frac{1}{2}$W
6	R31	Resistor, Carbon, 16 Megohm, 5%, $\frac{1}{4}$W
7	C-1	Capacitor, Ceramic Disc, 0.0027 UF, 10%, 50V
8	C-2	Capacitor, Tantalum, 47 UF, 35V
9	CR1,2,3	Diode, Silicon Rectifier, 1 Amp. Power Components
10	CR4,5	Diode, Type IN914
11	M1	Meter, Elapsed Time. Curtis Meter 10980
12	R1 thru R22	Resistor, Carbon, 10K Ohm, 10%, $\frac{1}{4}$W
13	Q1 thru Q22	Semiconductor Device, D16PC1
14	TP1	Test Jack. Amp #3-582118 (state color)
15		Printed Circuit Board with Components. Federal 8469B458

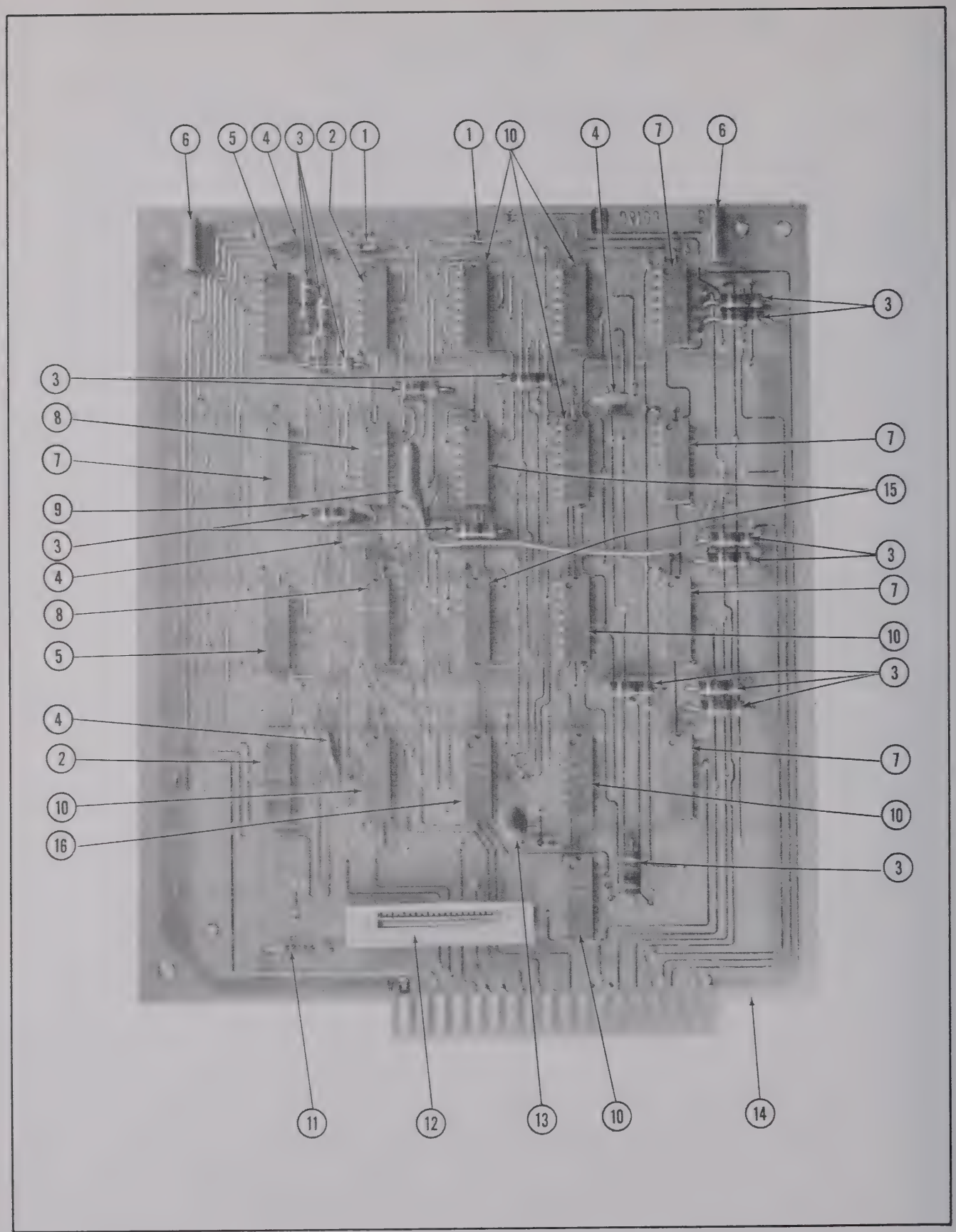

Figure 44. Time Component Board Assembly Drawing.

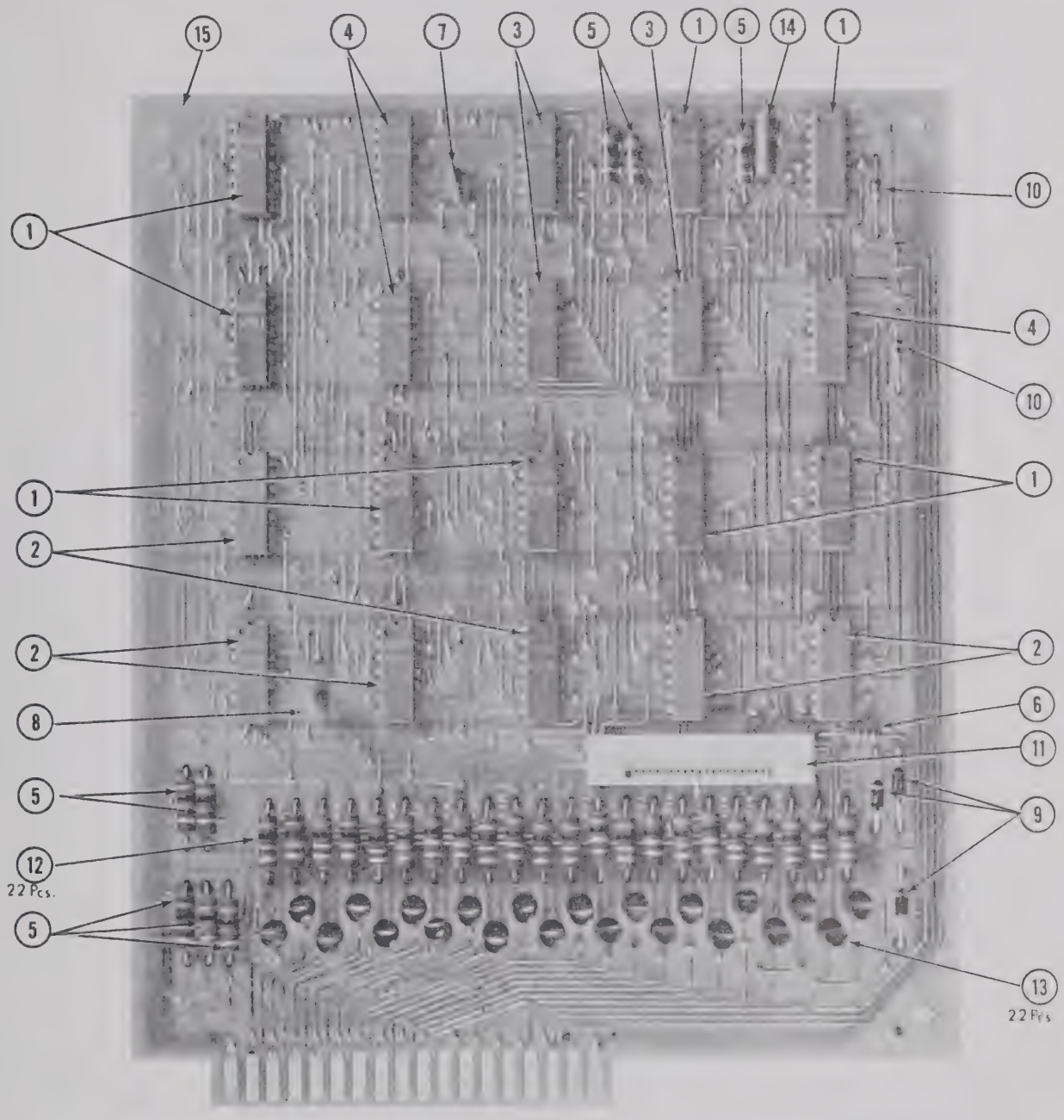

Figure 45. Speed Component Board Assembly Drawing.

D. Distance Component Board (6020). See figure 46A.

Item	Symbol	Description and Manufacturer
1	A1,A2,A3,A4	Integrated Circuit. Signetics, N8281A
2	B1,B2,B3,B4,C3	Integrated Circuit. Signetics, N8270A
3	C1,C4,D3,D4	Integrated Circuit. Signetics, SP322B
4	D1,D2,E2,E4	Integrated Circuit. Signetics, SP387A
5	E3	Integrated Circuit. Signetics, SP337A
6	E1	Integrated Circuit. Signetics, SP690A
7	C2	Integrated Circuit. Signetics, N8271B
8	R1,2,3,4,5,6,7,8, 9,10,11,12,14,16, 17,18,19	Resistor, Carbon, 1000 Ohm, 10%, $\frac{1}{2}$W
9	R21	Resistor, Carbon, 18K Ohm, 10%, $\frac{1}{2}$W
10	R20	Resistor, Carbon, 16 Megohm, 5%, $\frac{1}{4}$W
11	C-12	Capacitor, Tantalum, 47 UF, 35V
12	C-13	Capacitor, Tantalum, 1UF, 50V
13	C-4,6,7,8,9	Capacitor, Ceramic Disc, 0.0027 UF
14	C-10	Capacitor, Tantalum, 2.2 UF
15	M1	Meter, Elapsed Time. Curtis Meter No. 10980
16	TP4,5,6,7,8,9	Test Jack. Amp. #3-582118 (state color)
17		Printed Circuit Board with Components. Federal 8469B460

E. Distance Component Board (6049). See figure 46B.

Item	Symbol	Description and Manufacturer
1	A1,A2,A3,A4	Integrated Circuit. Signetics, N8281A
2	B1,B2,B3,B4	Integrated Circuit. Texas Instruments, SN7494
3	C1,C4,D3,D4	Integrated Circuit. Signetics, SP322B
4	C2	Integrated Circuit. Texas Instruments, SN7491A
5	C3,D1,D2,E2	Integrated Circuit. Signetics, SP387A
6	E1	Integrated Circuit. Signetics, SP690A
7	E3	Integrated Circuit. Signetics, SP337A
8	R6,7,8,9,10,11,12, 14,16,17,18,19,*22	Resistor, Carbon, 1000 Ohm, 10%, $\frac{1}{2}$W
9	R21	Resistor, Carbon, 18K Ohm, 10%, $\frac{1}{2}$W
10	R20	Resistor, Carbon, 16 Megohm, 5%, $\frac{1}{4}$W
11	C-14	Capacitor, Tantalum, 1.0 UF, 50V
12	C-4,6,7,8,9	Capacitor, Ceramic Disc, 0.0027 UF
13	C-12	Capacitor, Tantalum, 47 UF, 35V
14	C-10	Capacitor, Tantalum, 2.2 UF, 35V
15	M1	Meter, Elapsed Time, Curtis Meter No. 10980
16	TP4,5,6,7,8,9	Test Jack. Amp. #3-582118 (specify color)
17		Printed Circuit Board with Components. Federal 8469B460

* R22 is called out as R21 on some boards

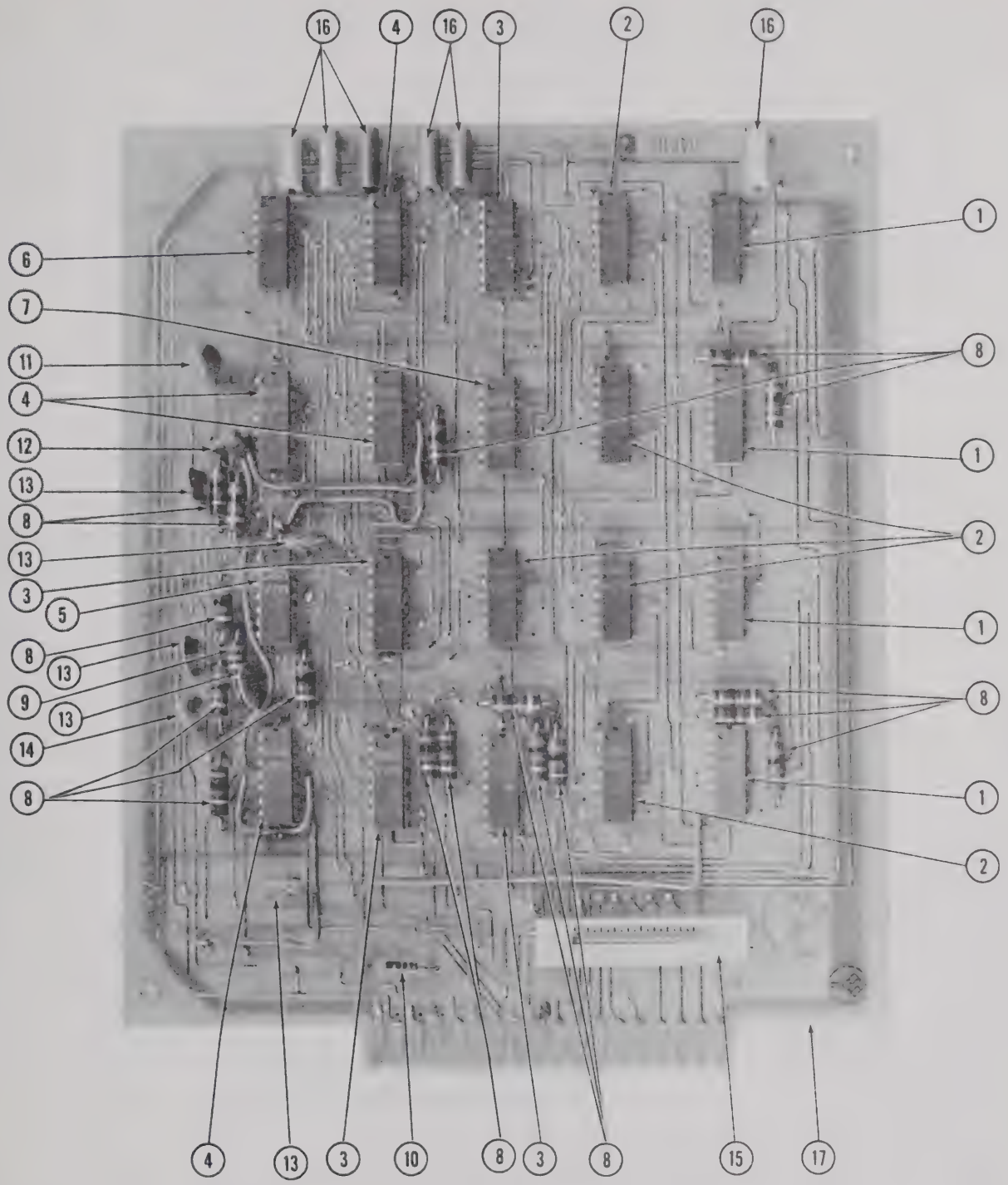

Figure 46A. Distance Component Board (Series 6020) Assembly Drawing.

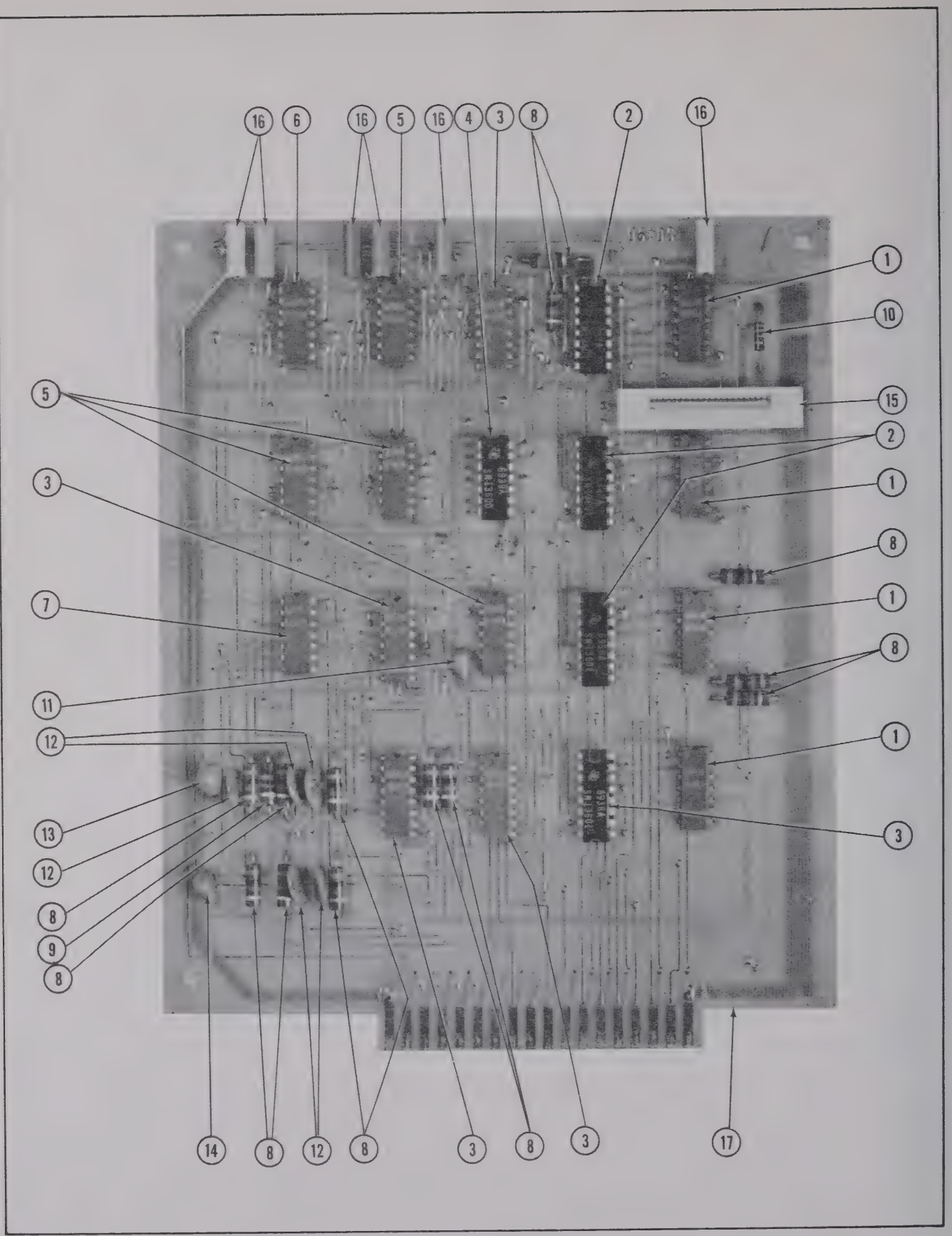

Figure 46B. Distance Component Board (Series 6049) Assembly Drawing.

6–5. POWER CABLE ASSEMBLY.

FEDERAL PART NO. 8469A395 (see figure 47)

Part No.	Description and Manufacturer
8469A394	Power cable
8469A384	Plug, Cinch-Jones S302-CCT-C
8469A48	Tie wrap
8469A101	Sleeving

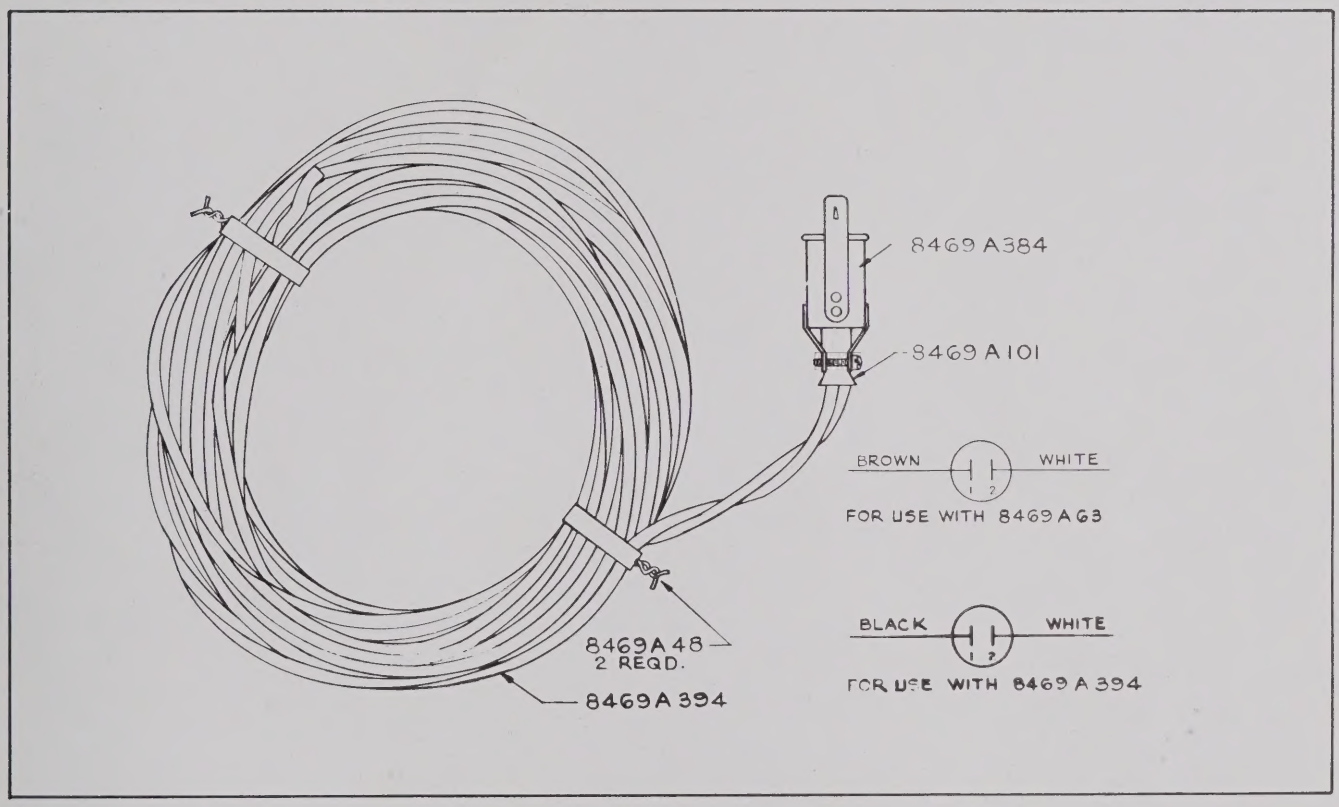

Figure 47. Power Cable Assembly Drawing.

FEDERAL
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CORPORATION

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Telex 2-54188

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